Operating and Service Manual

FAILURE TO RETURN THIS MANUAL
WILL RESULT IN A CHARGE OF

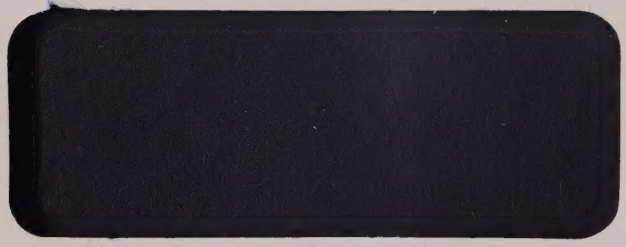
$25.00

Quick-Rental ™

WAVEFORM RECORDER AMPLIFIER
MODEL 13-4616-10
AND
AC/DC HIGH VOLTAGE COUPLER
MODEL 11-4310-18

Quick-rental instruments
GENERAL ELECTRIC CO.
2825 PACIFIC DRIVE, SUITE A
NORCROSS, GA 30071
PHONE (404) 662-1339

GOULD
Electronics & Electrical Products



GOULD

MANUAL PART NO.
13-804616-10

WAVEFORM RECORDER AMPLIFIER
MODEL 13-4616-10
AND
AC/DC HIGH VOLTAGE COUPLER
MODEL 11-4310-18

The information contained herein is the exclusive property of Gould Inc., except as otherwise indicated and shall not be reproduced in whole or in part without explicit written authorization from the company. The distribution of this material outside the company may occur only as authorized by the company in writing.

All information contained in this manual is the latest product information available at the time of printing. The right is reserved to make changes at any time without notice.

PRINTED 2/82
COPYRIGHT 1982

Gould Inc., Instruments Division
3631 Perkins Avenue, Cleveland, Ohio 44114

2nd PRINTING
PRINTED IN U.S.A.

GOULD

MANUAL PART NO.
13-804616-10

WAVEFORM RECORDER AMPLIFIER
MODEL 13-4616-10
AND
AC/DC HIGH VOLTAGE COUPLER
MODEL 11-4310-18

The information contained herein is the exclusive property of Gould Inc., except as otherwise indicated and shall not be reproduced in whole or in part without explicit written authorization from the company. The distribution of this material outside the company may occur only as authorized by the company in writing.

All information contained in this manual is the latest product information available at the time of printing. The right is reserved to make changes at any time without notice.

PRINTED 2/82
COPYRIGHT 1982

Gould Inc., Instruments Division
3631 Perkins Avenue, Cleveland, Ohio 44114

2nd PRINTING
PRINTED IN U.S.A.

WARRANTY

CURRENT EQUIPMENT:

The Gould Instruments Division's products as shown in the Current Equipment Catalog are warranted for a period of one year from date of shipment to original purchaser. They are warranted to conform to the applicable published specifications in effect at the time of shipment, and to be free from any defects in material or manufacture when used with recommended Gould associated equipment and Gould chart paper. LIABILITY OF THE GOULD INSTRUMENTS DIVISION UNDER SUCH WARRANTY IS LIMITED TO SERVICING OR REPLACING DEFECTIVE PARTS EXCEPT PENS, STYLI, FUSES AND BATTERIES AND DOES NOT INCLUDE CALIBRATION AND MINOR MAINTENANCE AS OUTLINED IN GOULD OPERATING MANUALS. (Exception: The thermal pen in the 110 Strip Chart Recorder is guaranteed for life.) IN NO EVENT SHALL THE GOULD INSTRUMENTS DIVISION BE LIABLE UNDER ANY CIRCUMSTANCES, FOR ANY LOSS OF PROFITS OR OTHER CONTINGENT, CONSEQUENTIAL OR SPECIAL DAMAGES. Units are to be returned transportation prepaid by the buyer. The Gould Instruments Division will have the right of final determination of the cause and existence of a defect under this warranty. This warranty shall not apply to any products which have been subjected to misuse, improper installation, repair, alteration, neglect, accident, inundation, fire or operation outside their published maximum ratings. THE FOREGOING WARRANTY IS EXCLUSIVE AND EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS AND OF ANY OTHER OBLIGATION AND SHALL CONSTITUTE THE SOLE REMEDY OF THE BUYER AND SOLE LIABILITY OF THE SELLER.

REPLACEMENT PARTS: Same as above —— except ninety (90) days from date of shipment.

If a defect occurs:

1. Notify your nearest ID Service Center (see below), giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data or shipping authorization and instructions will be forwarded to you.
2. On receipt of the shipping authorization, forward the instrument prepaid to location indicated on shipping authorization.

Compliance with the above procedure will assure the earliest repair and return of your equipment.

SERVICE CENTERS

BOSTON
INSTRUMENTS DIVISION
129 Middlesex Turnpike
Burlington, Massachusetts 01803
Phone: (617) 272-0750

BAY AREA (CA)
INSTRUMENTS DIVISION
25936 Eden Landing Road
Hayward, CA 94545
Phone: (415) 887-1300

CHICAGO
INSTRUMENTS DIVISION
1001 Oakton Street
Elk Grove Village, Illinois 60007
Phone: (312) 640-4380

CLEVELAND
INSTRUMENTS DIVISION
3631 Perkins Avenue
Cleveland, Ohio 44114
Phone: (216) 361-3315

DAYTON
INSTRUMENTS DIVISION
4668 Gateway Circle
Kettering, Ohio 45440
Phone: (513) 433-9586

DENVER
INSTRUMENTS DIVISION
1500 West Hampden Avenue
Unit 100C
Englewood, Colorado 80110
Phone: (303) 781-4473

DETROIT
INSTRUMENTS DIVISION
23775 Northwestern
Southfield, Michigan 48075
Phone: (313) 355-0900

COLUMBIA, SC
INSTRUMENTS DIVISION
c/o W.A. Brown Instruments Inc.
1201 St. Andrews Road
Columbia, SC 29210
Phone: (803) 798-8070

HOUSTON
INSTRUMENTS DIVISION
10500 Northwest Freeway
Houston, Texas 77092
Phone: (713) 680-1121

HUNTSVILLE, AL
INSTRUMENTS DIVISION
c/o W.A. Brown Instruments Inc.
7917-C Charlotte Drive
Huntsville, Alabama 35802
Phone: (205) 883-8660

LANHAM, MD
INSTRUMENTS DIVISION
5900 Princess Garden Parkway
Lanham/Seabrook, Maryland 20706
Phone: (301) 459-7350

LOS ANGELES
INSTRUMENTS DIVISION
2525 Campus Drive
Irvine, California 92715
Phone: (213) 639-7301

ORLANDO
INSTRUMENTS DIVISION
c/o W.A. Brown Instruments Inc.
222 Weber Avenue
Orlando, Florida 32803
Phone: (305) 425-5505

PHILADELPHIA
INSTRUMENTS DIVISION
GSB Building
Belmont & City Line Avenue
Bala Cynwyd, Pennsylvania 19004
Phone: (215) 839-7066

PITTSBURGH
INSTRUMENTS DIVISION
Campbells Run Road
Parkway West
Pittsburgh, Pennsylvania 15205
Phone: (412) 923-2160

SADDLEBROOK
INSTRUMENTS DIVISION
74 Kenney Place
Saddle Brook, New Jersey 07662
Phone: (201) 845-0220

SEATTLE
INSTRUMENTS DIVISION
The Commons Bldg. Suite C-155
1200 112th Avenue NE
Bellevue, Washington 98004
Phone: (206) 453-8100

TORONTO
ALLAN CRAWFORD ASSOC., LTD
6503 Northam Drive
Mississauga, Ontario, Canada
Phone: 678-1500

EUROPE

GOULD INSTRUMENTS S.A.F.
57 rue St. Sauveur 91160
Ballainvilliers, France
Phone: 909-10-67

GOULD INSTRUMENTS DIVISION
Roebuck Road
Hainault, Essex, England
Phone: 01-500-1000

GOULD INSTRUMENTS DIVISION
Dieselstrasse 5-7
D-6453 Seligenstadt,
West Germany
Phone: 06182-3107

TABLE OF CONTENTS

SECTION		DESCRIPTION	PAGE
I		GENERAL INFORMATION	1.1
	1.1	INTRODUCTION	1.1
	1.2	SPECIFICATIONS	1.4
	1.3	ACCESSORIES	1.6
	1.4	AC/DC HIGH VOLTAGE COUPLER	1.6
II		INSTALLATION	2.1
	2.1	GENERAL	2.1
	2.2	INITIAL INSPECTION	2.1
	2.3	INSTALLATION	2.1
	2.4	SIGNAL CONNECTIONS	2.1
	2.5	OUTPUT AND POWER CONNECTIONS	2.2
	2.6	SYSTEM CONNECTION	2.3
	2.6.1	Waveform Module Connection Procedure	2.4
III		OPERATION	3.1
	3.1	GENERAL	3.1
	3.2	FRONT PANEL CONTROLS	3.1
	3.3	INTNERAL CONTROLS	3.4
	3.4	BASIC OPERATING INSTRUCTION	3.6
	3.5	KEY APPLICATIONS	3.7
IV		THEORY OF OPERATION	4.1
	4.1	INTRODUCTION	4.1
	4.2	GENERAL	4.1
	4.3	SIGNAL BOARD	4.3
	4.3.1	Signal Conditioning Amplifier	4.3
	4.3.2	Anti-Aliasing Filter	4.3
	4.3.3	Triggering	4.6
	4.3.4	Sample Hold	4.6
	4.3.5	A/D Converter	4.7
	4.3.6	D/A Converter	4.7
	4.3.7	Reconstruction Filter	4.7
	4.3.8	Trigger Point Indicator	4.7
	4.4	CONTROL BOARD	4.9
	4.4.1	Clock Oscillator	4.9
	4.4.2	Sampling Control	4.9
	4.4.3	Memory	4.9
	4.4.4	Triggering Mode Control	4.9
	4.4.5	Trigger Delay/Pretrigger Control	4.9
	4.4.6	Chart Control	4.13
	4.4.7	Trigger Point Indicator Control	4.13
	4.4.8	Multiple Waveform Recording Control	4.13
	4.4.9	Panel Indicator Control	4.15
	4.5	POWER SUPPLIES	4.15

V MAINTENANCE 5.1

5.1 INTRODUCTION 5.1
5.2 PREVENTIVE MAINTENANCE 5.1
5.3 CALIBRATION 5.1
5.3.1 Mechanical/Visual Check 5.1
5.3.2 Calibration Procedure 5.4
5.4 TROUBLESHOOTING 5.7
5.4.1 STAR Diagram Signal Board/Control Board 5.7
5.4.2 STAR Diagram Test 5.8

VI PARTS IDENTIFICATION 6.1

A APPENDIX A.1

A.1 SCHEMATICS A.1

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
1-1	WAVEFORM RECORDER AMPLIFIER	1.2
2-1	WAVEFORM RECORDER REAR VIEW	2.1
2-2	OUTLINE DIMENSIONS	2.2
2-3	WIRING DIAGRAM WAVEFORM	2.6
2-4	WIRING DIAGRAM WAVEFORM	2.7
2-5	WIRING DIAGRAM WAVEFORM	2.8
3-1	FRONT PANEL CONTROLS WAVEFORM	3.2
3-2	CONTROL BOARD	3.5
3-3	TRIGGERING EXAMPLES	3.7
4-1	SIMPLIFIED BLOCK DIAGRAM WAVEFORM	4.2
4-2	TIME RELATIONSHIP/TRIGGER DELAYS	4.4
4-3	SIMPLIFIED DIAGRAM SIGNAL BOARD	4.5
4-4	TRIGGER POINT INDICATOR	4.8
4-5	BLOCK DIAGRAM CONTROL BOARD	4.10
4-6	A/D AND S/H TIMING	4.11
4-7	PRETRIGGER/TRIGGER DELAY AND COUNTER	4.12
4-8	EVENT MARKER GENERATION	4.14
5-1	WAVEFORM TEST BOX SCHEMATIC	5.2
5-1A	CALIBRATION BOX PARTS LIST	5.3
5-2	CONTROL BOARD	5.5
5-3	SIGNAL BOARD	5.6
6-1	WAVEFORM STORAGE MODULE	6.4
6-2	REAR PANEL ASSEMBLY	6.6
6-3	CONTROL BOARD	6.9
6-4	SIGNAL BOARD	6.13

SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Gould Model 13-4616-10 Single Channel Waveform Recorder extends a standard pen recorder bandwidth to 20KHz on a low duty cycle basis and provides the unique ability to be able to record pre-trigger signal information. This instrument is a new input signal conditioner which has the capability to capture high speed events, such as electrical disturbances, water hammer, mechanical shock, vibration, etc. Many of these events occur at a speed or rate of change too fast for direct writing recorders to follow, so the Waveform Storage Module was developed to store away this information in its own digital memory, and then automatically start up the recorder and play out the information at a much slower rate which the recorder can follow. It has a high impedance differential analog input, an easy no calculation set-up, automatic chart recorder start-stop or speed change features, and a trigger point indictor. It is a standard plug-in for either the Mark 200 or any of the 2000 Series Pen Recorders. It operates on the well-known recording principle of sampling an analog signal, converting a sample to a 10 bit digital number, and then storing sampled data in a 2048 word memory. Stored samples are then removed from memory at a fixed rate, applied to a digital-to-analog converter for analog signal reconstruction, where the analog signal is then made available for high resolution pen plotting. (Refer to Figure 1-1).

The user can select from a wide range of signal sensitivities, chart time, axis scale factors, frequency and signal level trigger, trigger delay, and percent of pre-trigger recording. A fixed analog playback rate in conjunction with a selected 50mm/sec. chart speed produces a standard 50cm chart display length. A 2x magnification, 100cm chart display length is accomplished by selecting the 100mm/sec chart speed. A standard input signal minimum sample resolution, memory data output rate, chart sample resolution, and chart speed provide the user with no-calculation, predetermined time axis scale factors. Time axis scale factors are indicated on the waveform recorder time base selector switch.

The design of this device allows multiple units to be readily interconnected for synchronized recording and plotting up to as many as 8 channels.

When this device is not in the process of plotting a transient waveform, the analog input signal is conditioned by the input amplifier and applied directly to the chart recorder pen servo amplifier. A front panel selector switch allows the user to disable waveform recording and use the input sensitivity selector as a d.c. amplifier type signal conditioner.

a. Major Product Features

1. High Impedance Differential Analog Input (2 megohms differential, 1 megohm each input to common).

2. Wide Measurement Range - .1 to 500V full scale in 12 selectable ranges.

3. Operates Off-Ground - up to 500V at any sensitivity.

4. Operates as a high frequency DC amplifier - flat to 100KHz.

5. Large Storage Capacity - 2K of memory allows for record times of 20msec to 5 sec depending on time base selected. Up to 5 plug-ins can be operated in series providing for 10K of memory in total and a 5 times expansion in record time.

6. Exceptional Waveform Reconstruction - A 10 bit A/D converter and a third order low pass butterworth output filter provides for reconstruction of sine-waves with no perceivable distortation or signal attenuation.

7. Eight Selectable Anti-Aliasing Filter Ranges - Provides for user assurance that waveforms are real. Simplicity of operation is provided since anti-aliasing filter setting is automatically selected in conjunction with the time base selection.

8. Nine Selectable Timebase Settings - Provide selectable bandwidths from 40Hz to 20KHz.

bi 2294

FIGURE 1-1 GOULD 13-4616-10 WAVEFORM RECORDER

9. Timebase Switch is also labeled by "Record Time", simplifying operation and need for user calculations.

10. Exceptional triggering accuracy and versatility is also provided.

    - Calibrated level triggering provides for accurate setting of trigger (typically $<\pm 2\%$); over a range of $\pm 100\%$ of full scale (dependent on input voltage range setting).

    - Frequency triggering - This unique Gould feature allows for selective rejection of AC signals to the level trigger circuit. Seven selectable ranges of high pass filtering from 50Hz to 5KHz is standard.

    - Window triggering - Allows for triggering on signals outside of a window defined by the level control.

    - External triggering is standard.

11. Pre-trigger viewing - Allows for displaying that portion of the waveform which occurred before the trigger. Five selectable settings are standard (0 to 100% pre-trigger).

12. Trigger Delay - The memory load can be delayed at 1, 2 or 3 memory load cycles as determined by a front panel control. The duration of the memory load cycle is determined by the time-base setting.

13. Operates in manual or auto triggering modes.

    - Manual provides single shot operation; the ability to expand or contract the record by changing recorder chart speeds and the ability to make multiple copies of an event/test.

    - Auto mode allows trigger circuit to be automatically armed after an event has been captured and displayed on a recorder. This provides the ability to retain multiple events on permanent records.

14. Operates as real time recorder and/or transient recorder.

    - Real time data can be displayed and events are recorded and dumped from memory only upon a trigger. Recorder goes back to real time recording and looks for another trigger.

15. Up to eight (8) waveform recorders can be operated in parallel. Synchronization of triggering is user determinable.

16. Master/slave operation is internally switch selectable. Units can be operated as masters or slaves in any combination.

    - Master operation allows the unit to generate a trigger, triggering itself and all other plug-ins.

    - Slave can only be triggered externally or by a master.

17. Wide frequency range - DC up to 20,000Hz.

18. Set-up requires no calculations - simply select highest frequency.

19. Calibrated frequency triggering used in conjunction with amplitude triggering.

20. Multi-range signal input - 100 millivolts to 500 volts.

21. Automatic error signal monitoring - unattended start-stop operation or chart speed multiplication.

22. Fully floating input - operates grounded, floating or up to 500 volts off-ground.

23. 2048 data words of storage with ten bit resolution.

24. Select up to 100% pre-trigger data readout or up to 300% of trigger delay.

25. Operates as high frequency DC amplifier or as a waveform storage module.

1.2 SPECIFICATIONS

Frequency Measurement Range

Using a minimum 10 samples per cycle . . . . . DC to 10,000Hz.
Using a minimum 5 samples per cycle . . . . . DC to 20,000Hz.

Sampling Rate . . . . . .400Hz to 100,000Hz in 1-2-5 sequence.

Storage Capacity . . . . . .2048 data words with 10-bit resolution.

Record Time Sequence

With one module . . . . . 5 sec to 20 milliseconds on 1-2-5 sequence.
With four modules in tandem . . . . . 20 sec to 80 milliseconds in 1-2-5 sequency.

Amplitude Input Range . . . . . 100 millivolts to 500 volts full scale.*

Attenuator Steps . . . . . .1, .25, .5, 1., 2.5, 5 volts full scale, OFF, plus x100 multiplier.

Attenuator Inaccuracy . . . . . ±0.5% of calibrated step.

Input Coupling . . . . . .Direct-Optional AC coupling is available.

Input Circuit . . . . . Balanced to floating common.

Input Impedance . . . . . 2 megohms differential, 1 megohm each terminal to common.

Common Mode Rejection

60Hz @ 1 kilohm unbalance . . . . . 90dB on most sensitive range.

Maximum Allowable Input Voltage . . . . . 500 volts peak, normal mode or common mode.

Input Signal Filter . . . . . .Low-pass with bandwidth set by time base selector.
24dB/Octave cut-off prevents aliasing.

Gain Instability (after 15 minute warm-up) . . . . . ±0.8% of reading for 24 hours.
±0.02% of reading per °C.
±0.015% of reading for 10% line change.

Zero Line Instability (after 15 minute warm-up) . . . . . ±0.15% of full scale for 24 hours.
±0.06% of full scale per °C.
±.0.015% of full scale for 10% line change.

Time Base . . . . . .1MHz crystal controlled master clock.

External Trigger . . . . . .Contact closure or 13mA current sink, TTL compatible.

* Up to 1500 volts full scale with optional high voltage probe.

Output Step Response. . . . . 1.2% overshoot when a 100% of full scale input STEP signal has a rise time greater than 1.5 microseconds.

Operating Temperature . . . . . 0 to +50°C (+32 to +122°F)

Humidity. . . . . 95% at +35°C (+95°F)

Power Input

Voltage DC . . . . . ±15VDC ±4% @ 80 milliamperes. +28VDC ±10% @ 50 milliamperes.

Voltage AC . . . . . 13V RMS ±10% @ 175 milliamperes.

Weight. . . . . 4.0 lbs. (1.8 kilograms)

Dimensions . . . . . 6.1" H x 2.18" W x 13.0" D (15.5cm H x 5.6 cm W x 33 cm D)

Signal Input Connector . . . . . AMP Series 1, circular, half-turn disconnect, 14 pin Gould Model No. 11-5407-10 (supplied).

Level Trigger Modes . . . . . Above +2% to +100% of full scale.
Below +2% to 100% of full scale.
Window (above or below) 2% to 100% full scale.
Above −2% to -100% of full scale.
Below −2% to -100% of full scale.

Frequency Trigger. . . . . High-pass, 4-pole active filter, flat at or above front panel setting.

Frequency Trigger Settings . . . . . 5, 2, 1, .5, .2, .1, and .05KHz plus OFF.

Trigger Arming Modes. . . . . Automatic or manual.

Recording Modes. . . . . 25%, 50%, 75%, or 100% of pre-trigger data or 0%, 100%, 200%, 300% of trigger delay.

Non-Linearity . . . . . ±0.3% of full scale, checked on stored waveform and includes inherent quantization uncertanity.

Output Data Rate . . . . . 200 data points per sec.

Output Voltage . . . . . ±5.0 volts into 2K ohms or greater.

Output Impedance . . . . . Less than 5 ohms.

Output Noise. . . . . ±0.1% of full scale, DC to 20KHz when signal is being tracked and converted.

1.3 ACCESSORIES

Input Signal and Interconnecting Cable (Two Harness Cable) 11-4310-16

Amp Series Connector which mates to the input supplied
(Only connector and pins) 11-5407-10

AC/DC High Voltage Coupler 11-4310-18

Power Supply Assembly 895990

Power Supply Adapter Assy for Portable
Carrying Case Units 11-4310-14

1.4 AC/DC HIGH VOLTAGE COUPLER SPECIFICATIONS

All specifications pertain to adapter box in conjunction with 13-4616-10 Waveform Recorder and 2000 Series Mainframe.

Signal Input Coupling ..... DC Differential AC/DC Single Ended

Connectors ..... 2-BNC (Low side connected to earth ground)

Maximum Input Voltage ..... 500Vdc or peak AC (Signal or Common Mode)

SECTION II

INSTALLATION

2.1 GENERAL

This section describes the checks and inspections that should be made upon receiving the Gould Waveform Recorder Amplifier Model 13-4616-10 with a 2000 series unit. It covers; installation procedures, signal input connections, and outline dimensions.

2.2 INITIAL INSPECTION

Prior to attempting any electrical connections or operation visually examine the unit for; broken or loose knobs, dented or nicked panels and broken or chipped rear connectors.

2.3 INSTALLATION

Amplifier Model 13-4616-10 may be mounted in Gould 2000 Recorder frames, Gould portable case or rack mounted separately in a Gould rack adapter kit.

a. Insertion

To install the preamplifier into its appropriate slot:

1. Slide the preamplifier into the enclosure until the rear output card edge connector is engaged.
2. Tighten the rear retaining screw. This locks the preamplifier into the enclosure.
3. Connect the 14-pin plastic input signal connector and secure it by turning the threaded plastic locking ring clockwise.

b. Removal

1. Disconnect the input connections with a counterclockwise turn of the connector and pull.
2. Loosen the rear retaining screw. The pre-amplifier will move forward about 1/8 of an inch.
3. Carefully slide the entire preamplifier out of the Gould 2000 enclosure.

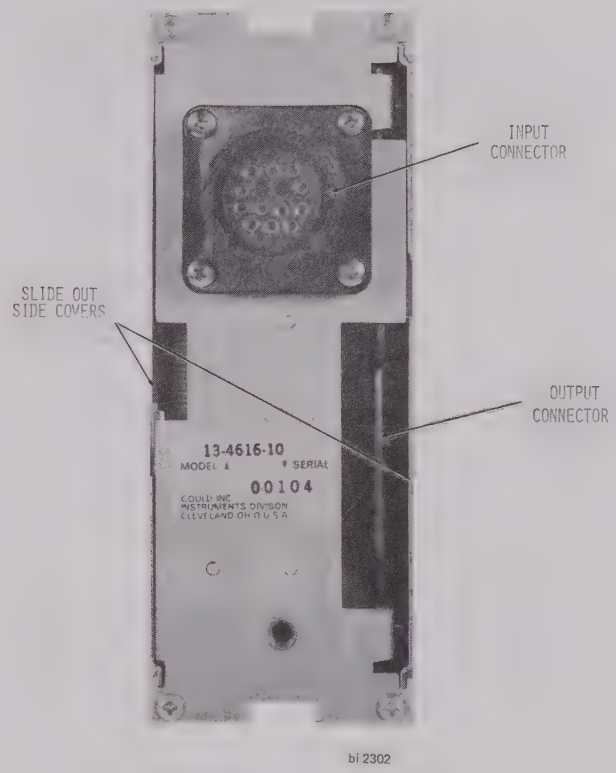


FIGURE 2-1 REAR VIEW

2.4 SIGNAL CONNECTIONS

a. General

Gould Waveform Recorder Amplifier Model 13-4616-10 has a fully floating input which operates grounded, floating or up to 500 volts OFF ground.

b. Input Connection Hardware

NOTE: For signal input connections, use the special connector provided with the preamp (Amp Series 1, Model No. 11-5407-10).

Connections to the preamplifier are made at the rear. (Figure 2-1)

NOTE: Ensure that all signal cable connectors are shielded properly.

c. Pin Connections

Amp series 1, circular, half-turn disconnect, 14 pin, Gould Model No. 11-5407-10 (supplied)

Pin 1 . . . . . (+) Input
Pin 2 . . . . . Common
Pin 3 . . . . . (–) Input
Pin 4 . . . . . .Chassis Ground
Pin 5 . . . . . N.C.
Pin 6 . . . . . N.C.
Pin 7 . . . . . .Chassis Ground
Pin 8 . . . . . Trigger
Pin 9 . . . . . .Chart Drive
Pin 10 . . . . . .+28 Volt Return
Pin 11 . . . . . .+28VDC
Pin 12 . . . . . .Recording Complete
Pin 13 . . . . . Record
Pin 14 . . . . . Plot Sync

2.5 OUTPUT AND POWER CONNECTIONS

The amplifier is designed to operate on + and –15 volts D.C. ±.6 volts at 80ma, +28VDC ±3 volts at 50ma and 13 volts RMS at 175ma. Output and power connections are provided through an 8 pin card edge on the rear of the preamplifier (Figure 2-1). The mating connector is located in the recorder chassis.

Card edge mates with Amp 16 pin no. 582140-5 or equivalent.

Pin 1 . . . . . Common
Pin 2 . . . . . .Signal
Pin 3 . . . . . .–15V
Pin 4 . . . . . +15V
Pin 5 . . . . . Signal Common
Pin 6 . . . . . N.C.
Pin 7 . . . . . AC Return
Pin 8 . . . . . AC
Pin A thru J. . . . . N.C.

NOTE: In order for the Waveform Module to operate, additional connections must be made to the +28 volt supply, the +28V Return, and the Chart Drive Signal Line. See Table 2-2.

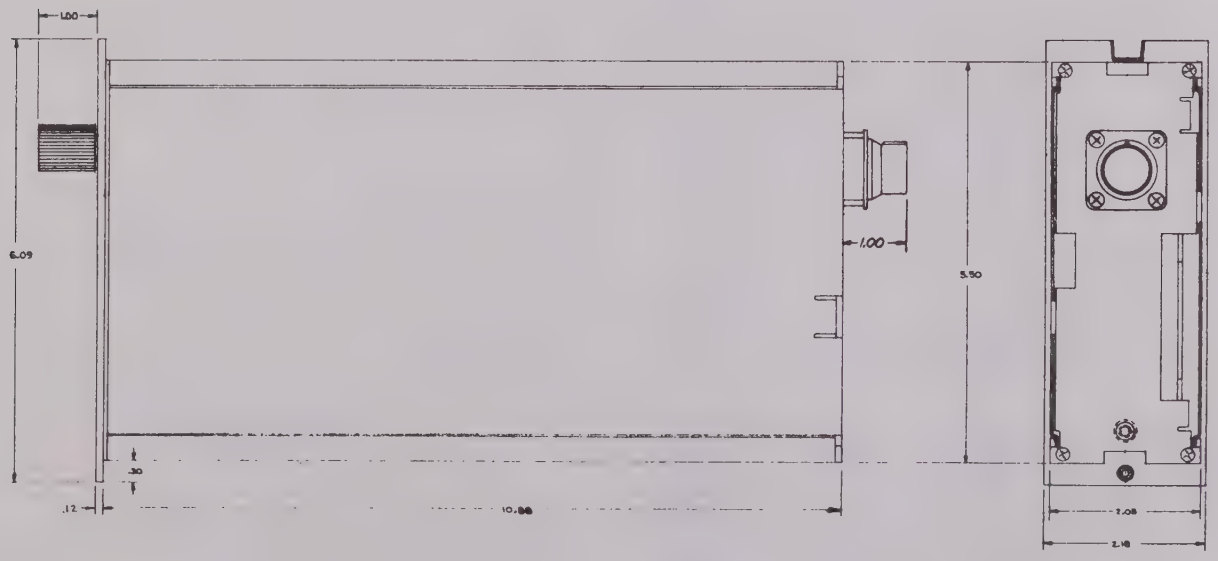


FIGURE 2-2 OUTLINE DIMENSIONS

2.6 SYSTEM CONNECTION

Multiple waveform recorders may be interconnected for synchronized recording and plotting of as many channels as required. A multiple master and/or slave system connection can be achieved.

Triggering of waveform recording is synchronized between all units and is generated only by recorders that have been internally selected to function as masters and/or by a remote trigger produced by a 13ma sink or a contact closure that occurs for less than 3 seconds. In addition, the output of amplitude data used for waveform plotting is synchronized from all units.

A random selection of time base scale factors, input scale factors, and percent of pre-trigger or trigger delay length is allowed on each of the waveform recorders in a multiple channel recording system.

Each waveform plotted from a waveform recorder (not in a delayed trigger position) will contain a trigger point indicator mark. Each indicator is a line segment, produced in the direction of pen motion, that has a minimum peak-to-peak amplitude of 13% of the chart width. The extremities of the indicator line are equal distance on either side of the waveform trace.

There are five control signals, listed in Table 2-1, that are interconnected between waveform recorders in a multichannel system for synchronization of recording and plotting. They are available on the rear panel user connection. This signal is used to control the chart drive motor and is used in a single as well as a multichannel system.

TABLE 2-1 CONTROL SIGNALS

ITEM	CONTROL	DESCRIPTION
1	$\overline{\text{Chart Drive}}$	A pair of normally open contacts is used for chart recorder remote chart drive operation. This pair of signals are wired ORed to all waveform recorders in a multichannel system. For normal operation of single or multiple waveform recorders and a 2000 series chart recorder, the jumper between pins 3 and 4 on the chart recorder rear panel terminal strip must be removed and replaced with the $\overline{\text{CHART DRIVE}}$ signal. A contact closure, originating at any waveform recorder operating in the master mode of operation, across these pins will enable the chart drive motor.
2	$\overline{\text{Trigger}}$	A pulse type signal that informs all waveform recorders in a multichannel system of the occurrence of a trigger event at one or more of the master units or from a remote trigger source. All units use this signal as their individual trigger point.
3	Recording Complete	This signal level is necessary in a multichannel system to disable waveform plotting until all recorders have completed storing a full cycle of waveform amplitude data. Non-coincident storage completion times will occur when dissimilar record time and/or percent of pre-trigger or trigger delay selections are made in a multichannel system.

ITEM	CONTROL	DESCRIPTION
4	$\overline{\text{Plot Sync}}$	A signal level that is used with a multichannel system. This signal is wire ORed to each waveform recorder and is used to synchronize the start of waveform plotting. It causes all recorders to begin to output memory amplitude data at the same instant in time.
5	Record	A signal level used in multichannel systems, which is wire ORed to each waveform recorder. After a plot it holds off resetting and recording new information, if one of the master units is in the MANUAL mode. When **ALL** the waveform recorders have been either manually "armed" or are in the "AUTO" mode, RECORD will rise and allow all units to reset and begin recording new information.

2.6.1 Waveform Module Connection Procedure

This procedure allows only a front panel preselected chart speed during waveform recorder operation. The recommended preselect chart speed is 50 mm/sec.

To accomplish waveform recorder operation, with a 2000 or 2000S series oscillographic recorder, the following steps must be taken (Refer to Figure 2-3):

To use several Waveform Storage Modules, the following limit must be placed on event marker operations.

Waveform Recorders	Maximum Allowable Event Markers
1	9
2	8
3	8
4	7
5	6
6	5
7	5
8	4

All speeds and operations are as standard operation.

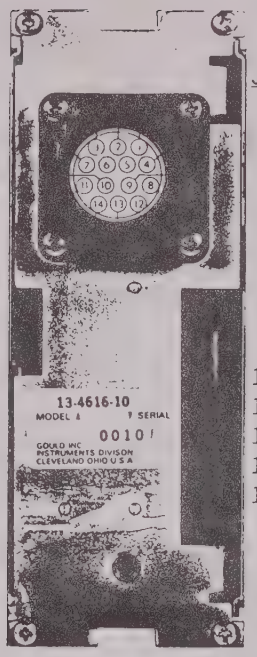
To accomplish multiple waveform storage operation with standard 2000S Stepper series oscillographic recorder, refer to Figure 2-4.

With the Waveform Storage Module wired as shown in Figure 2-4, the operator can select any front panel speed, and the chart will run at that speed. At this time,the Waveform Storage Module is continuously recording "live" information. However, when the Waveform Storage Module is triggered, the chart drive speed will change to the pre-determined remote speed, and the stored information will be plotted at the pre-determined remote selected speed. For example, the operator needs to monitor an A.C. power line for noise. The signal will be continuously recorded live at the front panel selected speed until a noise spike triggers the Waveform Storage Module. At this time the Waveform Storage Module will jump to the faster remote selected speed and output an expanded version of the noise spikes.

To accomplish multiple storage operation with standard 2000 Series Oscillographic Recorder, refer to Figure 2-5.

DIAGRAM I

WIRING DIAGRAM FOR WAVEFORM RECORDER
WHEN USING GOULD RECORDER 2X0X-XXXX-XX



J101

1 **YELLOW + INPUT SIGNAL
2 SIGNAL COMMON SHIELD*
3 ** BROWN - INPUT SIGNAL
4
5 CHASSIS GROUND*
6
7
8
9
10
11
12
13
14

TRIGGER

*CAUTION: (1) DO NOT INTERCONNECT CHASSIS GROUND BETWEEN CHART RECORDER AND WAVEFORM RECORDER(S)

(2) DO NOT INTERCONNECT GROUND SHIELD BETWEEN WAVEFORM RECORDERS

(3) NEVER CONNECT A CHASSIS GROUND TO 28 VOLT RETURN

** COLOR CODED FOR HARNESS ASSEMBLY 895181

COLOR CODED FOR HARNESS ASSEMBLY 795182.

WHEN REMOTE STOP START IS ACTIVATED FRONT PANEL SPEED SELECTION WILL DETERMINE STORED MEMORY PLAYBACK SPEED.

50 MM/SEC. Chart SPEED must be preselected

REMOVE REMOTE JUMPER

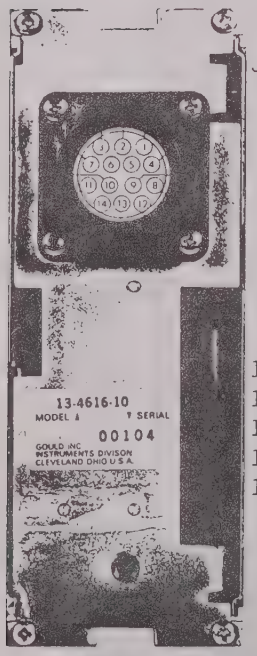
RED +28 VOLTS
BLACK 28 VOLT RETURN
WHITE CHART DRIVE

TB101

WAVEFORM RECORDER CAN BE EXTERNALLY TRIGGERED WHEN AN ADDITIONAL SWITCH IS PLACED BETWEEN 28 VOLT RETURN AND TRIGGER

DIAGRAM II

WIRING DIAGRAM FOR WAVEFORM RECORDERS
WHEN USING GOULD RECORDER 210X-XXXX-XX



J101

1 **YELLOW + INPUT SIGNAL
2 SIGNAL COMMON SHIELD*
3 ** BROWN - INPUT SIGNAL
4
5 CHASSIS GROUND*
6
7
8
9
10
11
12
13
14

CHART DRIVE
TRIGGER

*CAUTION: (1) DO NOT INTERCONNECT CHASSIS GROUND BETWEEN CHART RECORDER AND WAVEFORM RECORDER(S)

(2) DO NOT INTERCONNECT GROUND SHIELD BETWEEN WAVEFORM RECORDERS

(3) NEVER CONNECT A CHASSIS GROUND TO 28 VOLT RETURN

** COLOR CODED FOR HARNESS ASSEMBLY 895181

COLOR CODED FOR HARNESS ASSEMBLY 795182.

PINS 3 AND 4 MUST BE JUMPERED

RED +28 VOLTS
BLACK 28 VOLT RETURN
WHITE

TB101

J-102 REMOTE CONTROL

WAVEFORM RECORDER CAN BE EXTERNALLY TRIGGERED WHEN AN ADDITIONAL SWITCH IS PLACED BETWEEN 28 VOLT RETURN AND TRIGGER

MEMORY PLAYBACK SPEED OF 50 MM/SEC. IS PROVIDED WHEN PINS 3, 4, 5 AND 8 ARE JUMPERED TOGETHER.

FIGURE 2-3 WIRING DIAGRAM WAVEFORM FOR 2000 OR 2000S SERIES RECORDER

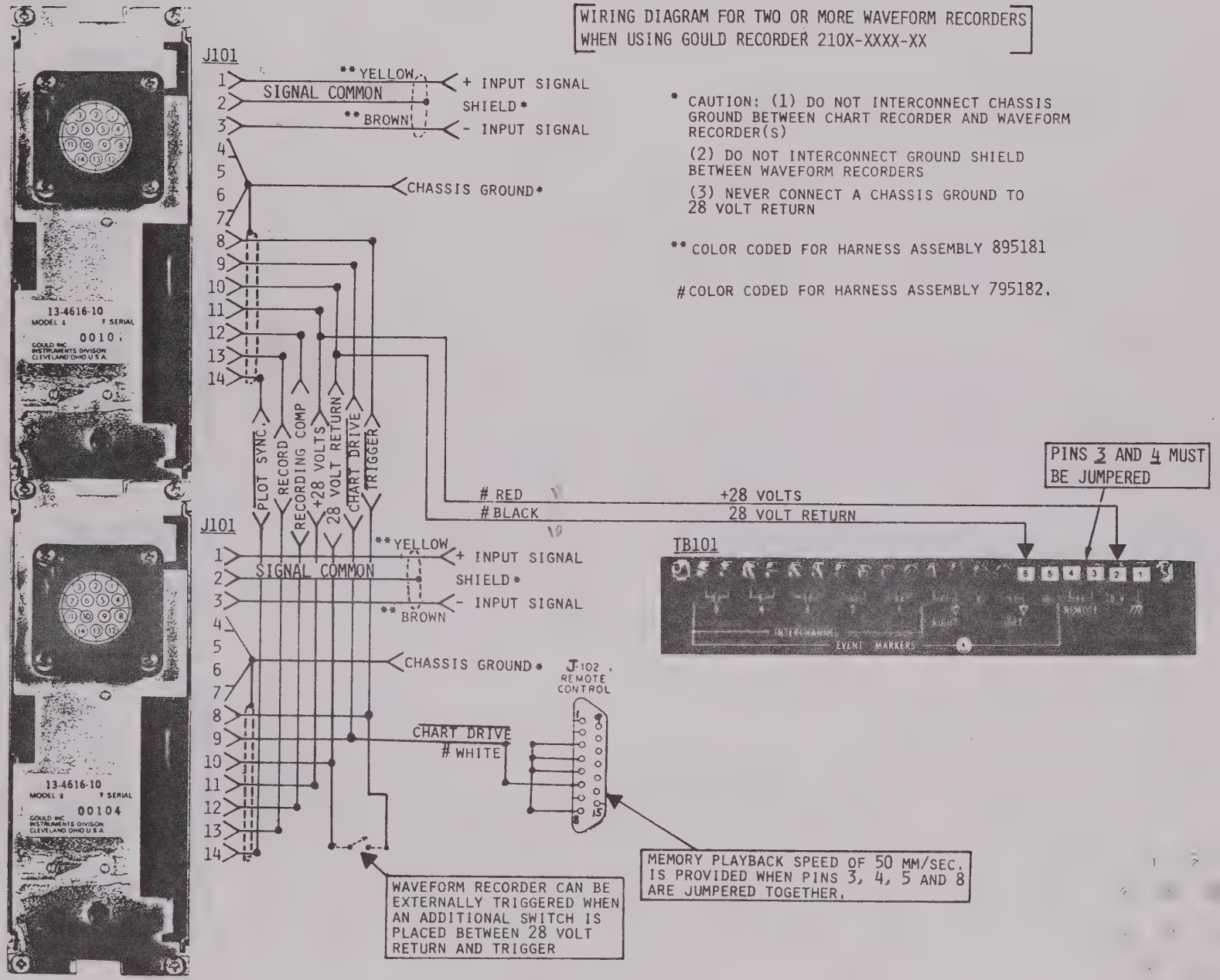

WIRING DIAGRAM FOR TWO OR MORE WAVEFORM RECORDERS WHEN USING GOULD RECORDER 210X-XXXX-XX
* CAUTION: (1) DO NOT INTERCONNECT CHASSIS GROUND BETWEEN CHART RECORDER AND WAVEFORM RECORDER(S)
(2) DO NOT INTERCONNECT GROUND SHIELD BETWEEN WAVEFORM RECORDERS
(3) NEVER CONNECT A CHASSIS GROUND TO 28 VOLT RETURN
** COLOR CODED FOR HARNESS ASSEMBLY 895181
# COLOR CODED FOR HARNESS ASSEMBLY 795182.
J101
** YELLOW
+ INPUT SIGNAL
SIGNAL COMMON
SHIELD*
** BROWN
- INPUT SIGNAL
CHASSIS GROUND*
PLOT SYNC.
RECORD
RECORDING COMP
+28 VOLTS
28 VOLT RETURN
CHART DRIVE
TRIGGER
RED
BLACK
+28 VOLTS
28 VOLT RETURN
PINS 3 AND 4 MUST BE JUMPERED
TB101
J101
** YELLOW
+ INPUT SIGNAL
SIGNAL COMMON
SHIELD*
** BROWN
- INPUT SIGNAL
CHASSIS GROUND*
J102 REMOTE CONTROL
CHART DRIVE
WHITE
MEMORY PLAYBACK SPEED OF 50 MM/SEC. IS PROVIDED WHEN PINS 3, 4, 5 AND 8 ARE JUMPERED TOGETHER.
WAVEFORM RECORDER CAN BE EXTERNALLY TRIGGERED WHEN AN ADDITIONAL SWITCH IS PLACED BETWEEN 28 VOLT RETURN AND TRIGGER

FIGURE 2-4 2000S SERIES RECORDER MULTIPLE WAVEFORM WIRING

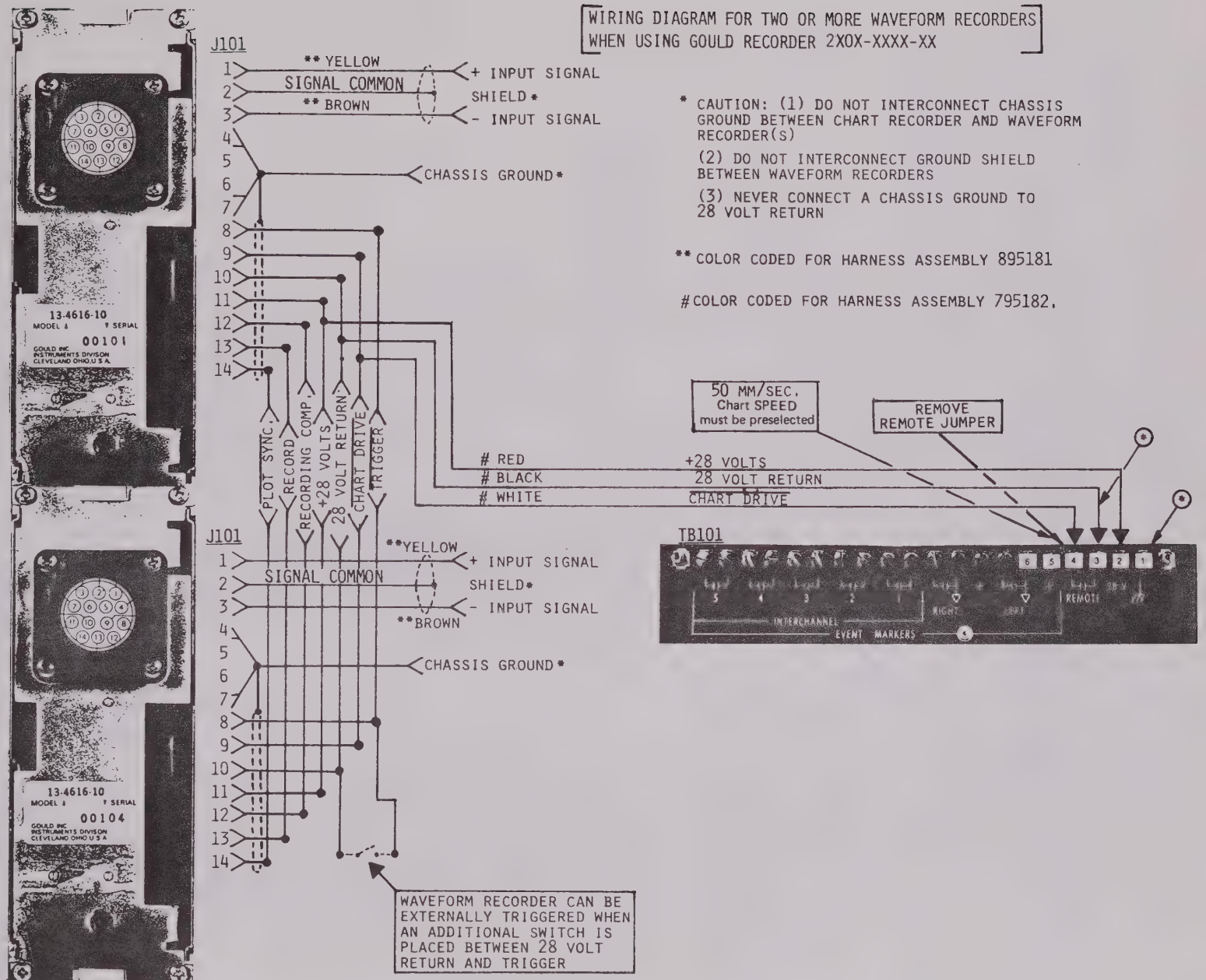

WIRING DIAGRAM FOR TWO OR MORE WAVEFORM RECORDERS WHEN USING GOULD RECORDER 2XOX-XXXX-XX
J101
** YELLOW
SIGNAL COMMON
** BROWN
+ INPUT SIGNAL
SHIELD*
- INPUT SIGNAL
CHASSIS GROUND*
PLOT SYNC.
RECORD
RECORDING COMP.
+28 VOLTS
28 VOLT RETURN
CHART DRIVE
TRIGGER
* CAUTION: (1) DO NOT INTERCONNECT CHASSIS GROUND BETWEEN CHART RECORDER AND WAVEFORM RECORDER(S)
(2) DO NOT INTERCONNECT GROUND SHIELD BETWEEN WAVEFORM RECORDERS
(3) NEVER CONNECT A CHASSIS GROUND TO 28 VOLT RETURN
** COLOR CODED FOR HARNESS ASSEMBLY 895181
# COLOR CODED FOR HARNESS ASSEMBLY 795182.
50 MM/SEC. Chart SPEED must be preselected
REMOVE REMOTE JUMPER
RED +28 VOLTS
BLACK 28 VOLT RETURN
WHITE CHART DRIVE
TB101
REMOTE
INTERCHANNEL
EVENT MARKERS
WAVEFORM RECORDER CAN BE EXTERNALLY TRIGGERED WHEN AN ADDITIONAL SWITCH IS PLACED BETWEEN 28 VOLT RETURN AND TRIGGER
13-4616-10
00101
00104
GOULD INC INSTRUMENTS DIVISON CLEVELAND OHIO U S A

FIGURE 2-5 2000 SERIES RECORDER MULTIPLE WAVEFORM WIRING

SECTION III

OPERATION

3.1 GENERAL

This section describes and illustrates the controls of the Waveform Recorder and provides instructions for proper operation. Before attempting to use the amplifier it is imperative that the operator completely understand the functioning of the controls and the required input/output specifications.

3.2 FRONT PANEL CONTROLS

The items listed below correspond to controls shown in Figure 3-1.

TABLE 3-1 FRONT PANEL CONTROLS

ITEM	CONTROL	DESCRIPTION
1	Master (DS101)	When this green light-emitting diode is illuminated it indicates that the waveform recorder has been selected as a master unit. When this LED is not illuminated, it indicates that the waveform recorder is a slave.
2	Time Base Selector (S1) Time/CM/Bandwidth/Record Time	A rotary switch that selects the rate at which the input voltage is to be sampled and converted to a digital number, and stored in memory. Each position of the time base selector switch has three recording parameters illustrated. These parameters are chart time axis scale factor in ms/cm, maximum input frequency that will be recorded without attenuation in KHz, and the input signal recording period in seconds. The ms/cm scale factor designations require that a pen recorder chart speed of 50mm/sec be selected. Selecting a 100mm/sec chart speed gives a 2x plot magnification. The nine selectable parameter positions are listed in the table below.

Time/CM	Bandwidth	Record Time
.4 ms/cm	20KHz*	20ms
.4ms/cm	10KHz	20ms
1ms/cm	4KHz	50ms
2ms/cm	2KHz	.1s
4 ms/cm	1KHz	.2s
10 ms/cm	400Hz	.5s
20 ms/cm	200Hz	1s
40 ms/cm	100Hz	2s
100ms/cm	40Hz	5s

* **NOTE: Anti-Alaising filter is removed when using the 20KHz front panel time base selector bandwidth position.**

3	x1-x100 (S101)	Two position toggle switch. Multiplies settings of volts full scale switch.

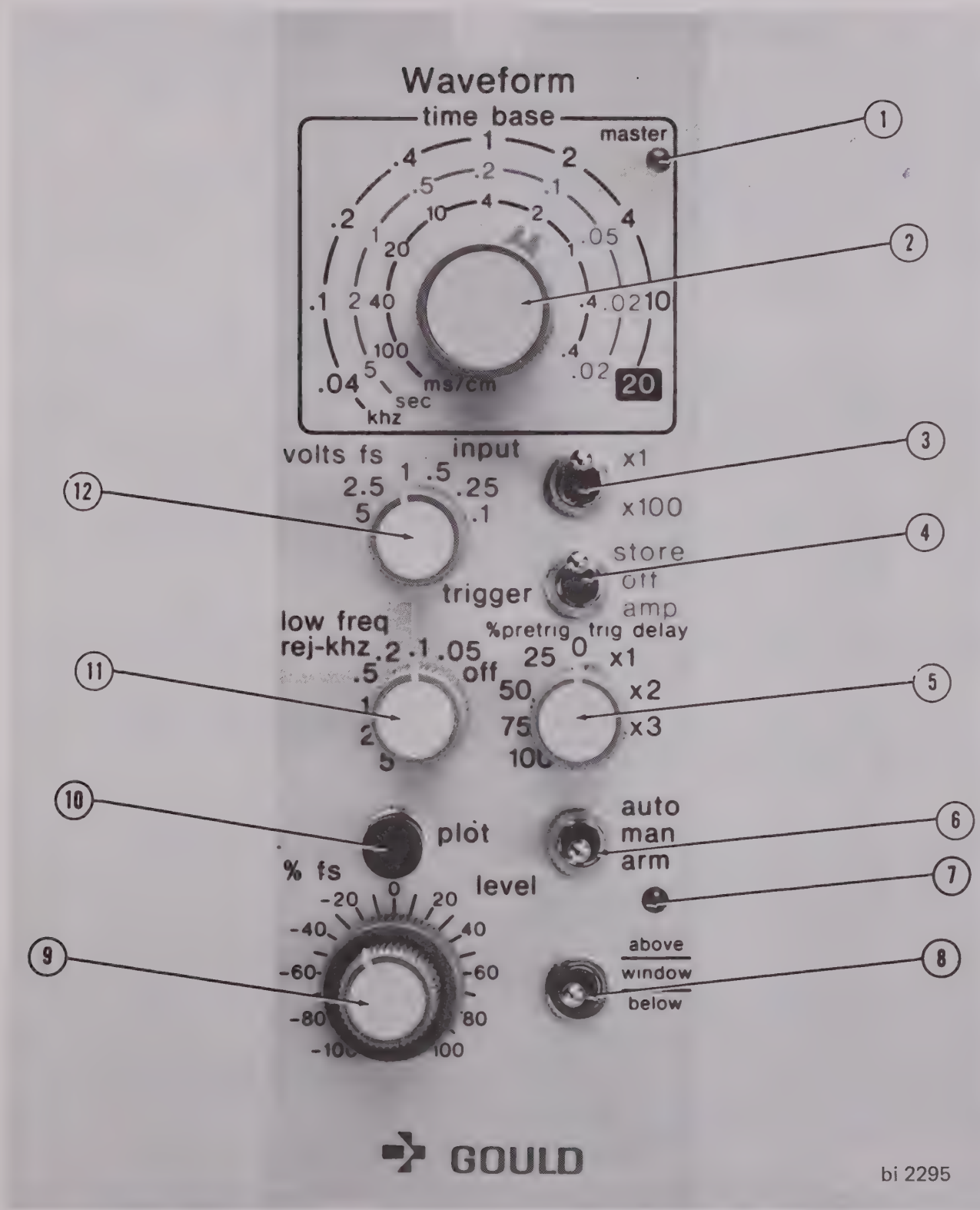


FIGURE 3-1 GOULD 13-4616-10 OPERATOR'S CONTROLS

ITEM	CONTROL	DESCRIPTION
4	Amp/Off/Store (S102)	A three position toggle switch that is used to select an appropriate output from the module. The "OFF" position connects the output to common for pen positioning purposes. The "AMP" position connects the output to the front end signal conditioner, allowing the module to operate as a D.C. Amplifier. The "STORE" position connects the output to the waveform storage circuitry. The chart paper will move at the selected chart speed when this switch is in either the AMP or OFF positions.
5	% Pre-Trigger Delay(S103)	An eight position selector switch that selects 0, 25, 50, 75 or 100 percent of the recording period to occur immediately prior to the trigger signal or a selection of x1, x2, or x3, multiplied by the time base record time setting to occur prior to waveform recording.
6	Auto, Manual, Arm (S106)	A three position toggle switch that is used to select the mode of operation. Two positions, AUTO and MANUAL, are retainable and one position, ARM, is momentary selectable.
7	Armed (DS102).	A red light-emitting diode that illuminates when the trigger circuitry has been armed. It will extinguish when a trigger occurs.
8	Above/Window/Below (S104).	A three position toggle switch that selects whether waveform recording can be triggered in the region above, below, or outside a window, set by the level adjustment.
9	Level (R101).	A vernier control that allows selection of a trigger voltage reference level. The control multiplies from −100 to +100 percent of the input volts full scale switch setting. This control is used in combination with the above/window/below three position toggle switch.
10	Plot (S105)	A pushbutton switch that allows the operator to manually initiate a plot cycle when the module is in the "MANUAL" mode, and has already been triggered.
11	Low Frequency Reject (S3)	A seven position rotary switch that selects the frequency limit above which a trigger will occur. The switch selects OFF, .05, .1, .2, .5, 1, 2, and 5KHz limits.
12	Volts Full Scale (S2)	A rotary selector switch that sets the full scale sensitivity of the waveform recorder. The switch selects .1, .25, .5, 1, 2.5, and 5 volts full scale.

3.3 INTERNAL CONTROLS

TABLE 3-2 INTERNAL CONTROLS

ITEM	CONTROL	DESCRIPTION
1	Master/Slave (S1) ..... (Refer to Figure 3-2)	A two position DIP switch, when in the master position, allows that waveform recorder to be a trigger producing source for itself as well as being able to synchronize the plotting of other waveform recorders. As a slave, the waveform recorder is incapable of producing a trigger. A trigger can be received from an external source or from any master connected in the system. A slave requires a master to synchronize the plotting of amplitude data.
	W2.....	With Jumper W2 installed, a trigger indicator is added to the output analog singal on the 100%, 75%, 50%, 25%, and 0% Pretrigger ranges. The removal of W2 inhibits the trigger indicator from being plotted.
	W5.....	With Jumper W5 installed, the input signal is filtered and directly output, while the Waveform Storage Module is armed and recording information (but not triggered). Once the trigger is sensed, the appropriate period of information will be stored and then plotted on the recorder. As soon as the module is rearmed, the input signal will be filtered and output directly again. The removal of W5 inhibits the input signal from being output while armed. The output plot is not affected.

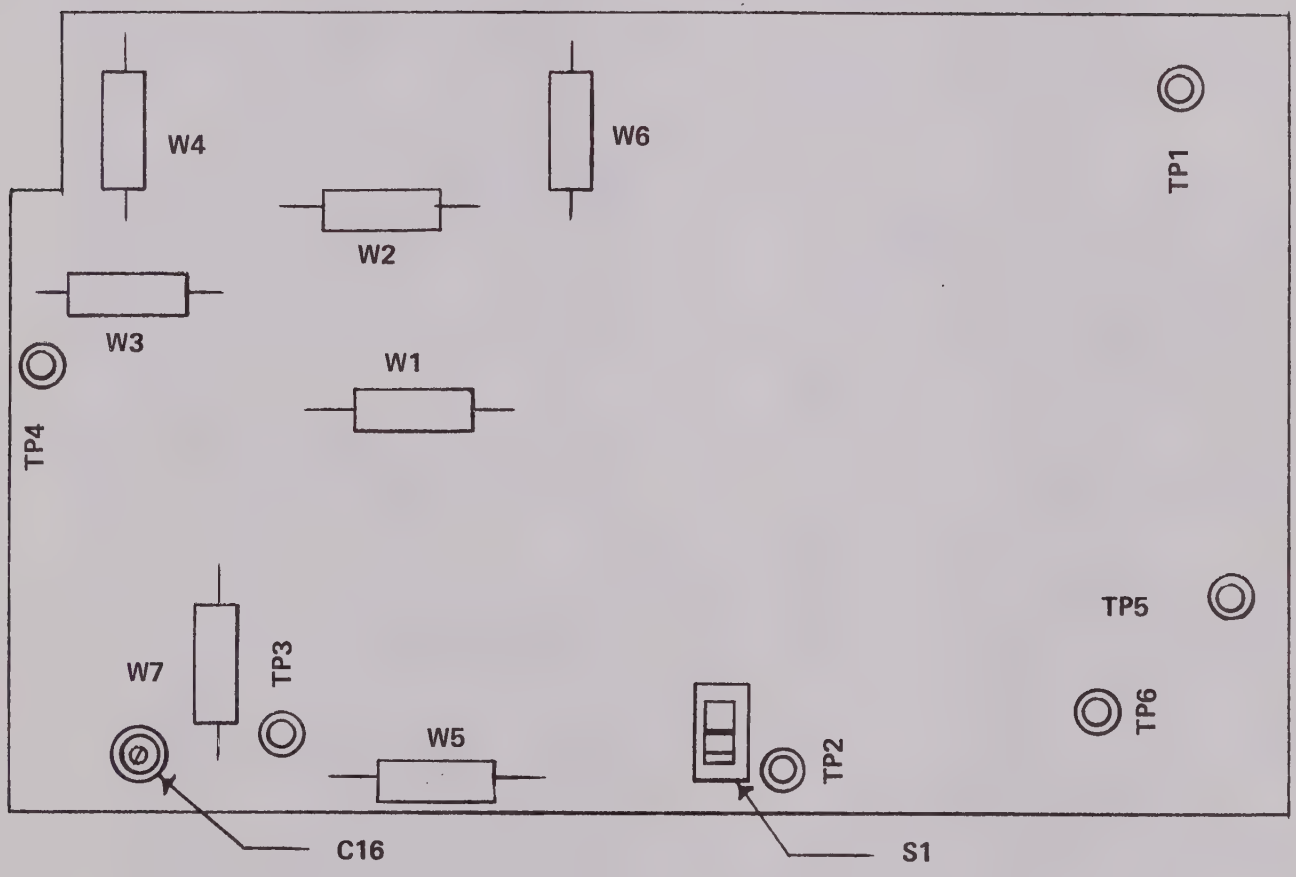


FIGURE 3-2 CONTROL BOARD

3.4 BASIC OPERATING INSTRUCTIONS

A. Remove right side Panel and set the board-mounted MASTER/SLAVE switch to the "MASTER" position (rocker depressed toward bottom of the preamp) to activate trigger controls in this module. Replace side panels.

B. Insert Preamplifier in a GOULD RECORDER or Portable Carrying Case and secure with thumbscrew on back.

C. Make sure the rear input connector is properly wired for power, communications, and signal input per the OPERATING AND SERVICE MANUAL, and then attach the connector to the Waveform Module.

D. Set STORE/OFF/AMP switch to "OFF" and AUTO/MAN/ARM switch to "MAN". Set recorder chart speed to "STOP" and turn the AC POWER "ON".

E. Run recorder at 5mm/sec and establish "ZERO" PEN POSITION on the chart, using the recorder "PEN POSITION" control. Set recorder chart speed to "STOP".

F. Establish full scale sensitivity:

1. If maximum input signal amplitude is 5 Volts or less, switch the X1/X100 toggle switch to "X1" position.

2. Turn VOLTS FS switch to the maximum signal amplitude expected.

3. Turn the TIME BASE switch to the maximum signal frequency expected.

4. Switch the STORE/OFF/AMP toggle switch to "STORE" position.

5. Set chart speed to "50" mm/sec. (Set chart speed to "STOP" for stepper recorders wired for remote operation).

G. 1. Connect the signal inputs as shown in Figures 2-4 and 2-5. Using optional harness assembly 895181, HIGH is YELLOW wire, LOW is BROWN wire, and cable shield is COMMON.

2. For single ended operation, connect cable shield to low input lead at signal source.

H. Establish trigger reference level:

1. For frequency trigger set LOW FREQ REJ selector switch to a value GREATER than the normal signal frequency. For amplitude trigger only, turn LOW FREQ REJ selector switch to "OFF". Note that all frequencies below the selected value will be attenuated only into the level trigger circuit.

2. Set % PRETRIG TRIG DELAY switch for ratio of information to be stored before and after occurrence of the trigger. (Suggest 25%).

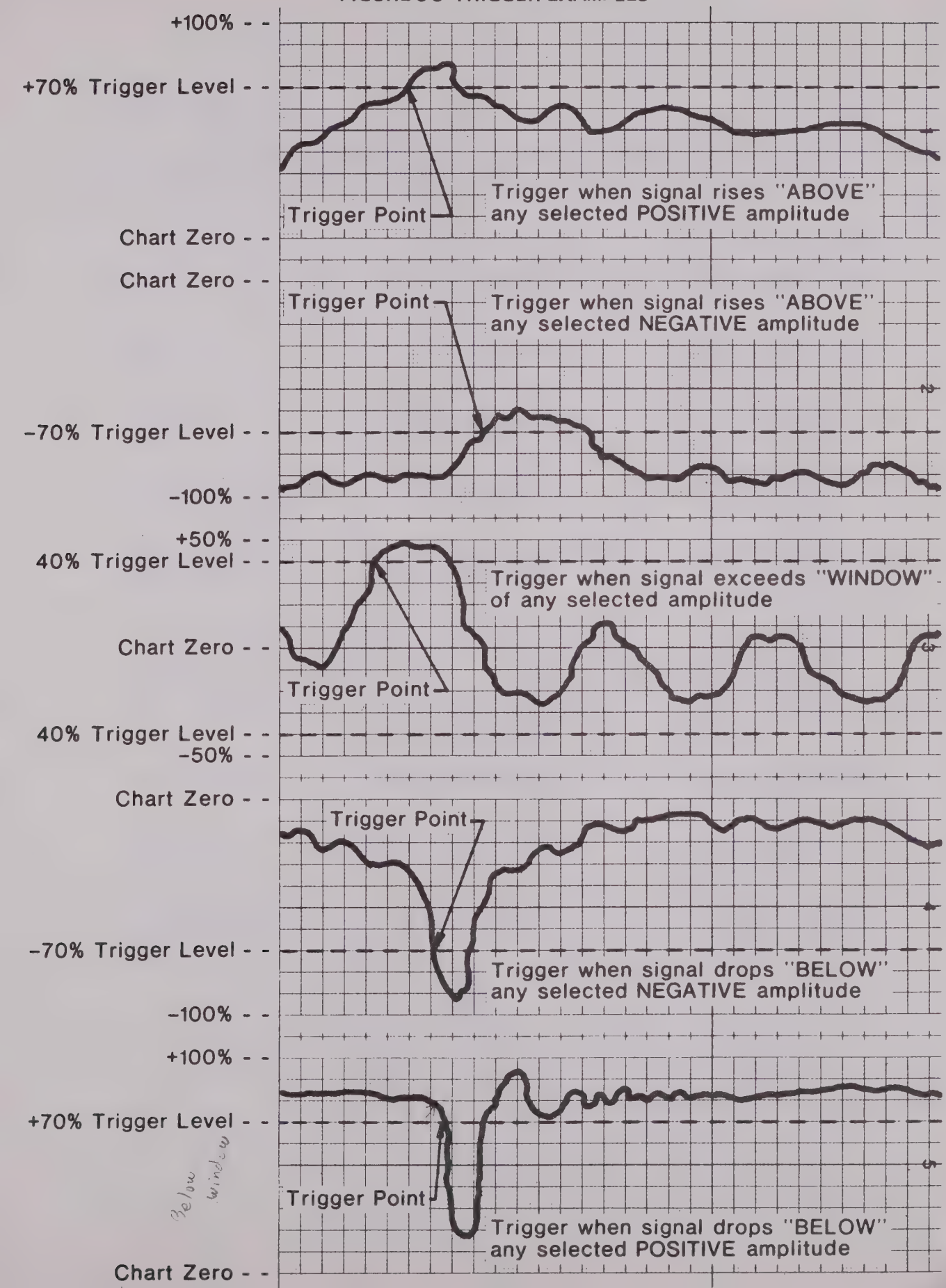
3. Select the limits of trigger detection to be above, below, or outside a window set by the threshold level control, using the ABOVE/WINDOW/BELOW toggle switch (see example, Figure 3-3).

4. Set the trigger LEVEL control to desired reference (percent of full scale).

5. Momentarily set AUTO/MANUAL/ARM toggle switch to "ARM".

I. System is now ready to receive Trigger and plot.

FIGURE 3-3 TRIGGER EXAMPLES



3.5 KEY APPLICATIONS

There are numerous markets and applications for this product, however a few have very large potential and our product offers definite user benefits. A listing follows:

INDUSTRY	APPLICATION	KEY FEATURE
Steel	SCR drive troubleshooting	2K of memory recorder presentation.
Aluminum	SCR drive troubleshooting	2K of memory recorder presentation.
Papermills	SCR drive troubleshooting	2K of memory recorder presentation.
Automotive & Construction and Farm Equipment	Shock & vibration	Convenient, high quality, low cost records.
Internal Combustion Engine Research	Shock, vibration performance and other tests.	Convenient, high quality low cost records, babysitting capability usable bandwidth.
Power Generating Companies	System monitoring	Frequency triggering, babysitting capibility.
Telephone Exchanges	System troubleshooting connect/disconnect.	Level triggering, babysitting capability.
Chemical Research	Reaction rate studies	Convenient, high quality, low cost records.
Heavy Industry (Large power users)	Power line monitoring	Babysitting/frequency triggering.
Computer Installation Troubleshooting	Power monitoring	Babysitting/frequency triggering.

APPLICATIONS

ASCII code transmission verification
Battery research
Brake materials testing
Circuit breaker testing
Chemical reaction rate studies
Crash testing
Diesel electric locomotive transient studies
Engine research
Flame research
Fuel cell development
Heavy machinery testing
Hydraulic research
Lubricant testing
Lung function
Material research (fracture studies)
Motor generator testing
Muscle tissue research
Nuerological research
Noise & vibration testing of rotating machines
Orchid fertilizer research
Paper product equipment testing
Power circuit testing
Power line monitoring
Power switch testing
Power transformer and insulator studies
Relay testing
Retina research
Rocket fuel burn rate studies
SCR drive monitoring
School bus seat development
Semiconductor research
Shear testing of plastics
Sonar sensitivity tests
Stress and strain analysis
Submarine propulsion system studies
Synchro and resolver calibration
Teaching
Telemetry equipment troubleshooting
Tensile testing of nuts & bolts
Thermal conductivity research
Torpedo testing and development
Typewriter motor analysis
Voltage cell research
Weld analysis

SECTION IV

THEORY OF OPERATION

4.1 INTRODUCTION

This instrument, a 4600 series signal conditioner, functions as an electronic single channel waveform recorder and is used to extend the useful bandwidth of 2000 series oscillographs up to 20KHz on a duty cycle basis. Operation of this device is based on the well known recording principle of sampling an analog signal, converting a sample to an equivalent digital number and then storing digital data in a memory. Stored samples are later removed from memory at a fixed rate, that is compatible with an oscillograph recorder frequency response, and applied to a digital-to-analog converter for analog signal reconstruction and high resolution pen plotting.

Included in this device is a high impedance differential analog input, an easy no calculation set-up, automatic chart recorder start-stop or speed change features, trigger point indicator added to the pen plot, and an analog output signal and cabinet that are compatible with existing 2000 series oscillographic recorders. External command and status signals are provided to allow multiple units to be readily interconnected for synchronized recording and plotting of up to three cascaded units or up to eight parallel channels.

4.2 GENERAL

With the aid of the simplified block diagram (refer to Figure 4-1), a good understanding of the waveform recorder can be obtained.

The waveform recording process begins by applying an analog signal to the instrument's high impedance differential input amplifier by way of the rear panel connector. Bipolar or Unipolar inputs are provided by the differential amplifier configuration. In addition to conditioning signals for recording, the differential amplifier can be used to directly apply signals to an oscillographic recorder for real time plotting of low frequency signals. At this point the signal is an amplified or attenuated version of the input.

From the input differential amplifier the signal is applied through a multiple pole active low pass filter (Anti-Aliasing Filter) to a sample-hold, and to a trigger sensing and control circuit. The filter attenuates undesired higher frequency components that produce Aliasing Effects in the output plot.

The waveform recorder is under the control of an internal crystal oscillator circuit, that has an output clock rate that is determined from the setting of the time base selector. The clock determines when signal voltage samples are to be taken and how they progress to the memory. Analog signals are sampled under clock control, with the sample and hold and then applied to an analog to digital converter, where it is converted into digital information.

The digital information is then applied to the static RAM memory that consists of 2048 digital addresses of ten bit data words. The ten bit digital word represents the magnitude and polarity of a signal sample. In actual operation, each time a sample of the input is taken it is converted and applied to a memory address location. When the next sample is taken and converted, it is applied to the next higher memory address location. A signal which is applied to the instrument's input will be sampled 2048 times before the memory is full and the conversion process discontinues. At this point the digital control starts the oscillographic recorder moving at the user preselected paper plotting speed and removes the digital information from memory at a 200Hz rate. The removed digital information is transformed to a stepped analog voltage by a digital to analog converter, and is applied to a low pass filter for signal reconstruction. The signal is then applied to the oscillographic recorder's drive amplifier for high resolution plotting at a rate that is compatible with the recorder's frequency response.

The front panel trigger controls and corresponding circuitry provide for internal frequency, level, selected slope, window triggering or from an external source. The external source can be another waveform recorder for multichannel synchronized recording. A unique feature of waveform recording is that of pretrigger recording. In normal operation an input signal is continually being sampled and stored in memory. Therefore, after the instrument has been powered on or a previous waveform has been plotted, the memory is automatically filled with the most recent 2048 samples of the input. In the absence of the trigger this information is constantly being updated and the older information is lost. This process causes the most recent 2048 samples of whatever had appeared at the input terminals to be stored. With

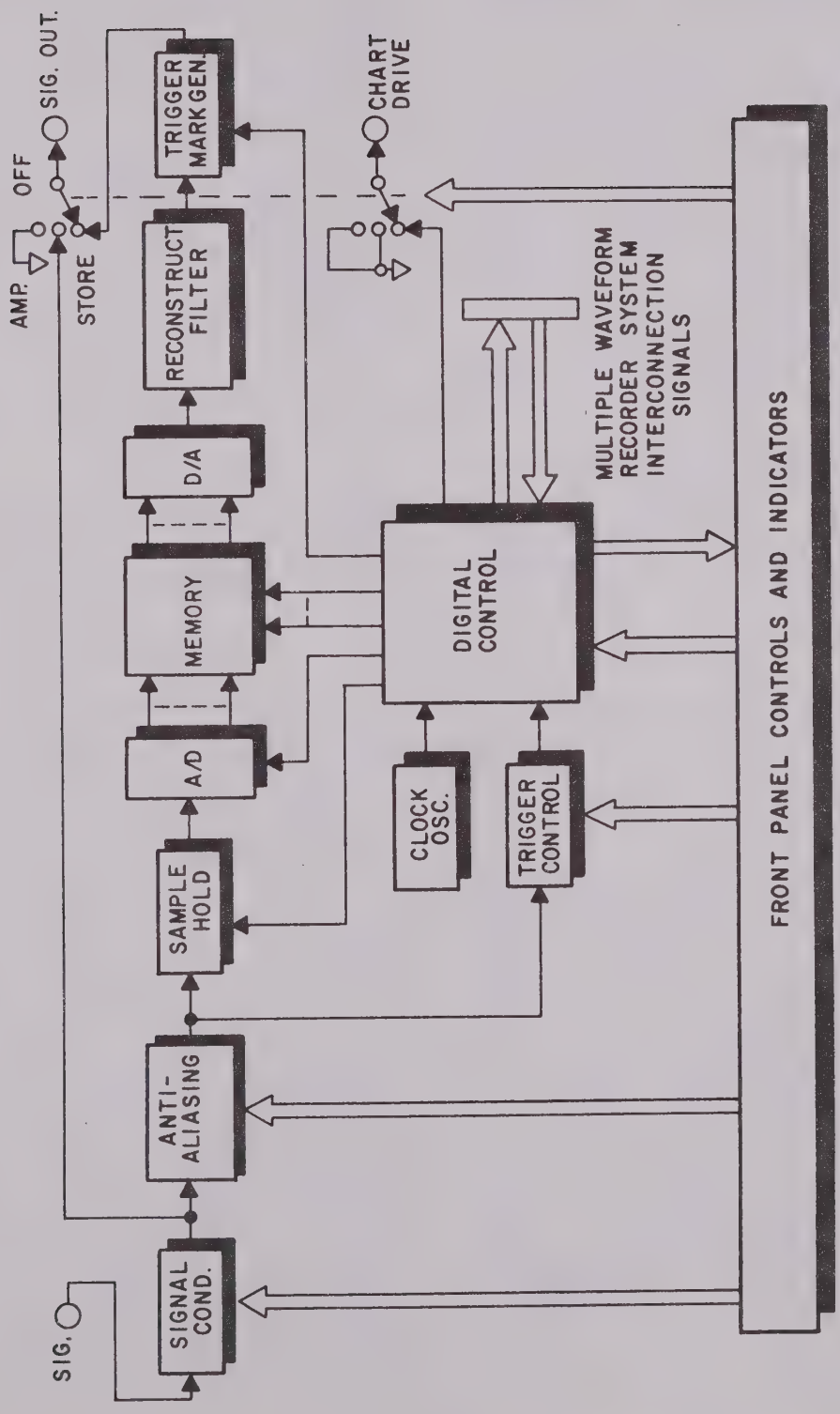


FIGURE 4-1 SIMPLIFIED BLOCK DIAGRAM WAVEFORM RECORDER

this instrument it is possible to trigger on an event and retain some of the prior history as well as to capture some of the signal immediately following the event. This is possible through use of the % of pre-trigger selector. The selector has 0%, 25%, 50%, 75%, and 100% positions. If set to 50%, only one-half of the memory will be permitted to take in new information after the trigger event and the other one-half of the memory will automatically retain information immediately preceding the trigger. In addition, a 1x, 2x, and 3x memory delay feature is provided on the same selector. If set to 1x, the time it takes to load 2048 samples into memory will pass after the trigger event and then the memory will be filled with samples that will be for subsequent plotting. Refer to Figure 4-2.

4.3 SIGNAL BOARD (REFER TO SCHEMATIC 294706)

In the paragraphs that follow, for part identification refer to schematic 294706. A signal board functional schematic Figure 4-3, also uses these part identifications and is a simplified version of the circuit schematic. Figure 4-3 is located at the end of this section.

4.3.1 Signal Conditioning Amplifier

The signal conditioning amplifier consists of a selectable gain differential input instrumentation amplifier stage preceded by a resistive attenuator, to extend the amplifier useful range to 500 volts full scale. The attenuator, which consists of resistors R15 thru R18, R40 and R41, provides a unity or 100 divisions of the input signal. Selection of one of the two attenuations is made by the front panel X1-X100 switch. Included on each attenuator output signal lead (+ and - to common) is a low leakage overvoltage protection circuit that disallows higher than absolute maximum voltages to be applied to the instrumentation amplifier.

The signal conditioning amplifier consists of three operational amplifiers that have F.E.T. input stages, U3 thru U5, connected into a differential input instrumentation amplifier configuration. The two input amplifiers make up a differential buffer amplifier with a gain of (1+2 RA/RB) for differential signals and unity gain for common mode signals. The voltage gain of the circuit arrangement is varied by resistor RB. Resistors RA and RB are contained in a thin network of matched resistors, U14, and the value of RB is selected by S21 of the front panel "Volts/Full Scale" switch. A gain selection of 1, 2, or 5 is available at the buffer amplifier configuration. The non-inverting configuration of these input amplifiers ensures high input impedance at both inputs.

The final amplifier, U5, acts as a differential-input to single-ended-output converter. Precision resistors associated with this amplifier, R24, R25, R31, and "Volts/F.S." switches S22 and S23 combine to provide gains of 0.4 and 4. Incorporated into this section of the signal conditioning amplifier is a constant gain of 0.4 that is necessary to the first section of the Anti-Aliasing filter. Therefore, the total combined gain range of this circuit is 0.4, 0.8, 2, 4, 8, and 20. This range is divided by 100 when X1-X100 switch is in the X100 position. The output of the signal conditioning amplifier is applied to an amplifier, U8-A, that has a fixed gain of 2.5.

Increasing the voltage adjusts the input to a standard five volt full scale that is required by an oscillographic recorder. The output of the non-inverting 2.5 gain amplifier is selected with the amp-off-store switch on the front panel when the waveform recorder is functioning in the D.C. amplifier mode.

4.3.2 Anti-Aliasing Filter

The conditioned input signal is applied to an active four pole low pass filter that has a constant gain in the pass band. This filter has a butterworth response, and its pole positions are changed by the front panel "Time Base" selector. Therefore, coupling it to the waveform recorder sample rate. The purpose of the anti-aliasing filter circuit is to attenuate signal components that have less than ten samples per sinusoidal cycle at an attenuation factor of -24dB per octave. The knee of the filter characteristic response curve, -3dB point, is at a frequency 1.67 above the selected bandwidth.

The first two active poles of the four pole circuit are generated by operational amplifier U8-B which has two resistors and two capacitors connected to it to form an active low pass filter. Switches S11 thru S14 insert and remove components to change the filter pole positions. This section of the total filter circuit has a gain of 2.5 in the pass band. A compensating gain of 0.4 has been included in the "Signal Conditioning Amplifier" section in order to maintain a 5 volt full scale voltage at the output of amplifier U8-B.

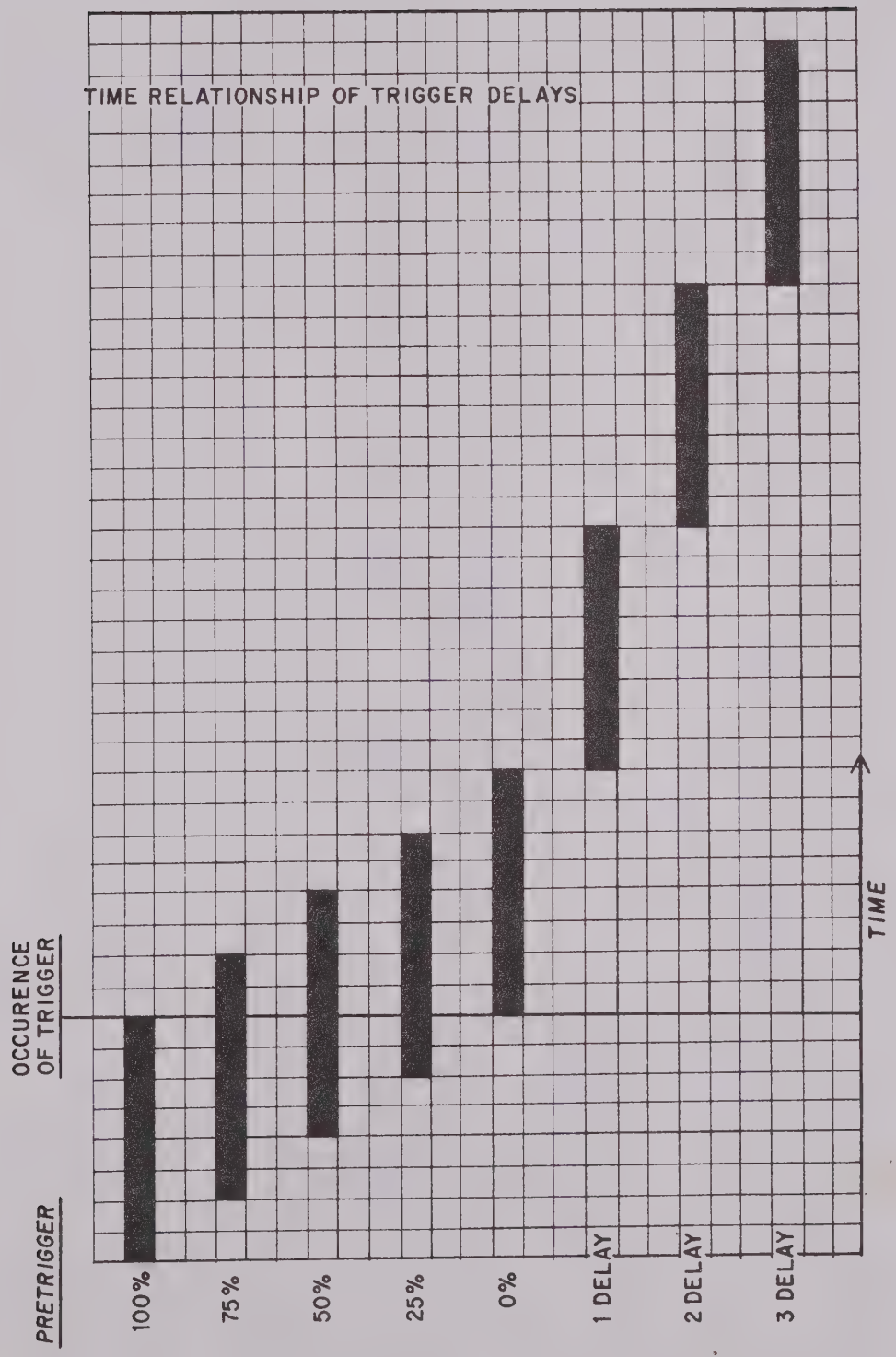


FIGURE 4-2 TIME RELATIONSHIP OF TRIGGER DELAYS

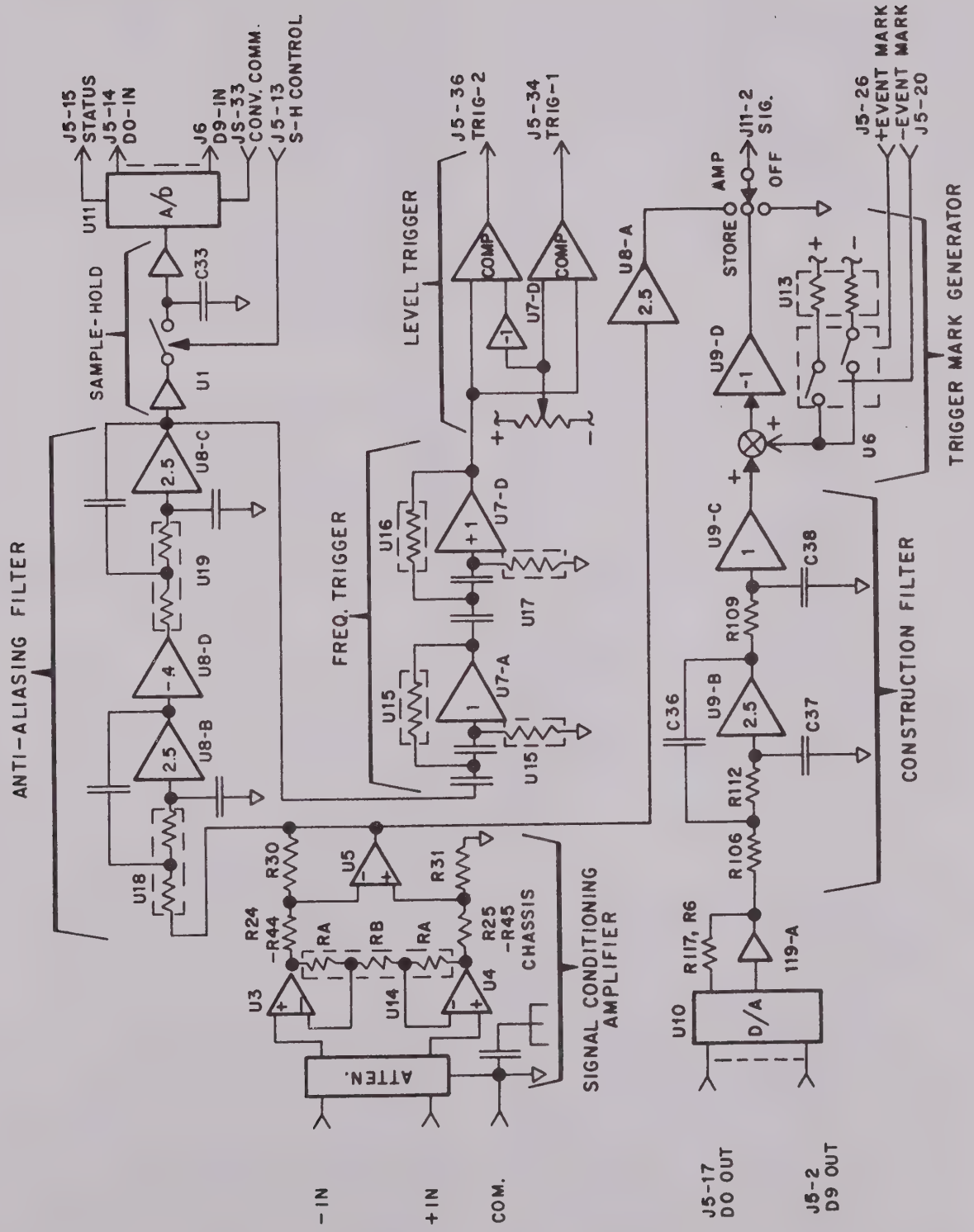


FIGURE 4-3 SIGNAL BOARD SIMPLIFIED SCHEMATIC

The second pole pair of the four pole filter is generated by amplifier U8-C and its associated resistors and capacitors. It has a circuit configuration identical to the first section, but has complex pole pair positions at a second location. The first and second stage combine to form the overall desired amplitude versus frequency response. A gain of 2.5 in the pass band is developed by the second stage, and amplifier U8-D, placed ahead of stage two, has a gain of -0.4. Therefore, causing the signal level at the filter output of U8-C, to be 5 volts full scale. "Time Base" switch S15 thru S18 change components connected to U8-C to adjust the position of the complex pole pair of this portion of the anti-aliasing filter.

Since the overall gain of the entire circuit is always negative and no other signal inversions occur before the signal is converted from an analog voltage to a digital representation, binary numbers stored in memory are inverted representations of signal samples. The stored signal is inverted a second time by the "Trigger Mark Generator". Therefore, a correct polarity signal is reconstructed at the waveform recorder output.

4.3.3 Triggering

In the triggering portion of the waveform recorder, there are two sections. First is the frequency filter. This is a four pole high pass chebyshev filter designed to attenuate frequencies whose range is selectable by a front panel switch. The gain of the filter is 1.0 at the selected frequency and above. The gain at half the selected frequency is 0.07. The purpose of this filter is to allow high frequencies to pass through and cause a trigger within the waveform recorder, while blocking the lower frequencies. The active elements are U7A and U7B.

The second section of the trigger is the level detection circuit. Ref. + and Ref. - are to be set to +5.00V and -5.00V respectively. The "Trigger Level" signal is the input wiper of the front panel "Trigger Level" pot. The input to U7C is where it is buffered (gain = +1.0). This buffered signal is sent two directions: First, to an inverter U7D (gain = -1.0),, which then drives a comparator U2B. R11 adjusts out the offset and biasing of the inverter. The other direction for the buffered "Trigger Level" is sent to a comparator U2A. Here it is added with the prescaled signal input voltage. If the total of the two add up to greater than 0V, then the output of the comparator will be -14.3V. If the total adds up to less than 0V, then the output floats high, pulled up by R81 and R91. R66 and R115 add a slight hysteresis (+10 to -25mv) to the circuit to eliminate any oscillations at the output. The diode CR5 on the output circuit limits the voltage out to be not less than -0.7V. This is for the CMOS circuitry located on the control board. The same theory is true for comparator U2B except it is working with the inverse of the trigger level.

4.3.4 Sample Hold

Sample and hold amplifier U1 samples the continuously varying conditioned and filtered input signal, then holds the instantaneous signal value upon the command of the "S-H Control" logic signal obtained from the control board. Basically the sample and hold is an analog memory where external capacitor C33 serves as the storage element. This circuit, contained in a single integrated package, is conceptually a high input impedance amplifier, an external capacitor, and an output buffer amplifier. To enter the sample mode the "S-H Control" input is taken to the logic "1" state which commands the internal switch closed and allows the input amplifier to make the storage capacitor (C33) voltage equal to the analog input voltage. In the hold mode the internal switch is open isolating the storage capacitor from the input and leaving it charged to a voltage equal to the last analog input voltage before entering the hold mode. The storage capacitor voltage is brought to the output by the output buffer amplifier.

The "Sample-Hold" circuit element is placed before the fast successive approximation analog-to-digital converter which cannot tolerate a time varying input during its conversion process cycle. The control board causes the "Sample-Hold" to retain in the hold mode for a maximum time of 6 μsec. Two micro-seconds of the total hold mode time is allowed to pass before the A/D converter, which receives its input signal from the "Sample-Hold output buffer amplifier, is commanded to perform the conversion from the analog voltage sample to an equivalent digital representation. The delay between the beginning of the hold mode and the beginning of a data conversion is provided to allow the "Sample-Hold" output buffer amplifier and A/D converter input operational amplifiers to stabilize before starting the analog-to-digital transformation.

4.3.5 A/D Converter

The A/D Converter is contained in a 32 pin dual in-line package and is used to convert a signal sample to a ten bit binary equivalent for subsequent storage in a digital random access memory located on the control board. The converter is confined to accept bipolar input signals, + or -5V, and to produce an offset binary coded output. The data outputs are available in parallel form. Since the anti-aliasing filter causes a signal polarity inversion, the output binary number is an inverted representation of the analog signal sample. The inversion is corrected later in the waveform recording and plotting process.

The converter uses the successive approximations technique to perform complete ten bit conversion in a maximum time of 4 μsec with +1/2 L.S.B. relative accuracy. The successive approximation technique compares the analog input with the output of a digital-to-analog (D/A) converter that tests each bit successively, most significant bit (bit 1) is tested first, until the D/A output is equal to the analog input, within the quantizing error. A "0" to "1" transition of the "Convert Command" input, that is received from the control board sets the most significant bit output to logic "0" and the "Status" and bit 2 through bit 10 outputs to logic "1". Nothing further happens until the "Convert Command" returns to logic "0", at which time the conversion proceeds. This process continues through each successive bit until the bit 10, least significant bit, comparison is completed. At this time the "Status" output returns to logic "0" and the conversion cycle ends. The "Status" output is applied to the control board where it is used by the control logic circuitry to monitor the state of the converter action.

4.3.6 D/A Converter

The digital-to-analog (D/A) converter, U10, is contained in a 16 pin dual in-line package, and is utilized to restore an analog equivalent of digital data stored in the waveform recorder memory. It produces a bipolar output current proportional to the 10 bit digital input that is then transformed to a voltage by operational amplifier U9-A.

The operational amplifier is configured as a current-to-voltage converter. It has a scale factor set by resistors R6 and R117, and the output from this device is a bipolar (+ or -2V) voltage. The waveform produced at the combined D/A and operational amplifier circuit is an inverted staircase representation of the input signal. The 200 steps per second are filtered out by the "Reconstruction Filter", and the "Trigger Mark Generator" reinverts the signal to its correct sense.

4.3.7 Reconstruction Filter

The "Reconstruction Filter" is used in the process of reforming the analog signal that was applied to the waveform recorder from the flat top stepped votlage waveform produced at the output of the current-to-voltage amplifier, U9A. It is a third order low pass filter that has a butterworth magnitude characteristic response, which exhibits a flat amplitude response in the pass band. The -3dB breakpoint frequency occurs at 70Hz and the attenuation factor after this point is -18dB per octave. Basically the filter performs the function of removing the 200Hz memory data sample frequency from the stored signal without affecting the shape or amplitude of the stored waveform.

The filter realization consists of an active filter stage that produces a pair of complex poles followed by a real pole circuit. The complex pole stage consists of operational amplifier U9-B and components R106, R112, C36 and C37. This stage has a pass band gain of 2.5 and maximum bipolar voltage levels of + or -5 volts are provided at the output. The second stage that provides a real pole of amplifier U9-C, capacitor C38, and input resistor R109 and produces unity gain in the pass band.

4.3.8 Trigger Point Indicator

The purpose of the trigger point indicator circuit is to produce a vertical line equal distance above and below the waveform trace on the waveform that is plotted by an oscillographic recorder to indicate the point where waveform recording was triggered. (See Figure 4-4).

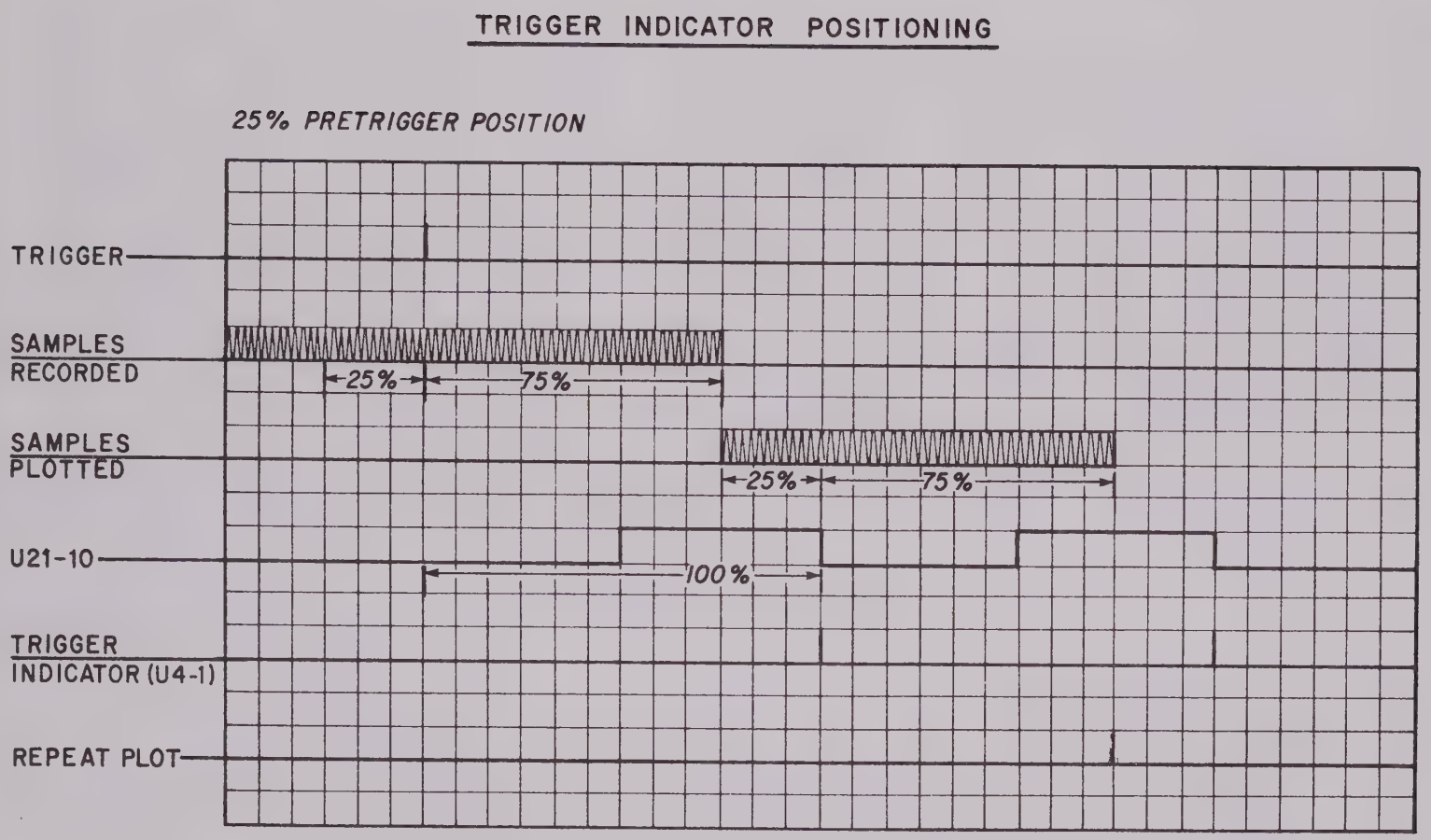


FIGURE 4-4 TRIGGER POINT INDICATOR

Summing and inverting amplifier U9-D is used to produce the line segment by the addition of a negative pulse followed by a positive pulse to the analog waveform signal from the "Reconstruction Filter". The negative pulse is generated when U6 connected in series with resistor network U13 and the positive voltage source is commanded close by the "-Event Mark" logic signal received from the control logic board. The positive pulse is generated in a similar manner when commanded by the "+Event Mark" logic signal. The output of amplifier U9-D is the waveform recorder output signal source when operating in the "Store Mode".

4.4 CONTROL BOARD

For all I.C. numbers and signal names refer to schematic 294705 and Figure 4-5.

4.4.1 Clock Oscillator

The oscillator is the heart of the system and is controlled by a crystal. An inverter I.C., U48, generates the master clock (MCLK), trimmable to 1.00000 MHz. The I.C.'s U32, U47,U16, U33 and U17 compose a divider network, which allows selection of the sampling rate of A/D conversion. U31 encodes the selector rate switch position, and forces U34 to output the proper frequency to be sent out to the memory control and A/D control circuits.

4.4.2 Sampling Control

The output of U34 noted above, begins each A/D conversion cycle. First a hold is sent to the sample and hold unit (U1), and then after 2 microseconds, the "Convert Command" (U42 pin 15) falls to a low condition, starting the A/D conversion. When the A/D is finished, it drops the status line to a low state, generating a conversion complete "Conv Comp". While recording new data, this conversion complete signal causes the memory control circuit to generate 1 microsecond pulses to the latch strobe "Latst", Memory Strobe "Memstrobe", and memory increment "Meminc", in that order. When recording, the latch strobe allows the contents of the A/D to be latched into U14 and U29, to be outputted to the analog pens for real time information. Memstrobe then causes the data to be recorded in memory and finally the memory is incremented. This process of conversion, strobing, and recording into memory will continue at the selected rate until a trigger occurs. (Refer to Figure 4-6).

4.4.3 Memory

U8 thru U13 are the RAM memories which record or return the data. The RAM address controller I.C's U6 and U7, continuously count up from 0 to 2048 (or 1024 if jumpered to 1K) and then 0 again. This allows continuous looping through the memory. U15 and U28 pass the data to the RAMs if in the recording state.

4.4.4 Triggering Mode Control

To reset the memory into a recording condition, a switch on the front panel allows U52 to indicate the mode of Manual or Automatic. Manual prohibits resetting until manually rearming the unit, via the front panel switch. Also, in the Manual mode only, a front panel pushbutton switch "Plot" allows U39 and U40 to start a repeat plot of the data in memory. If the switch is in the automatic position, when a chart recorder plot is completed, the end of plot signal causes U51 to change state and allow a reset to be sent through optical couplers U43 and U44. This signal is passed over to U36 and U19, where a write and trigger reset "Watr" pulse is generated. This signal goes back to U36 and U38, which allow new triggers and make the memory begin recording new data.

4.4.5 Trigger Delay/Pre-Trigger Control

U55 detects the position of the signal to the trigger level threshold; above the positive limit, below the negative limit, or in between the positive and negative limits. The trigger threshold common, returns the appropriately selected signal to U26 where it is logically anded with the master/slave signal line. If the waveform recorder is a slave unit, then an internal trigger is blocked. Only a master may generate a trigger and assuming the unit is a master, the trigger signal will pass to U54 (an optical isolator). The trigger will be sent out on the bus and follow through in the unit to U38. This flip-flop will allow the post-trigger counter U21 to begin counting. The pretrigger front panel switch will be decoded by U23, when the proper count is reached. The output of U23 will cause U36 to toggle stopping the writing into the RAMs (Memwrt level goes low), which begins the chart control sequence. (Refer to Figure 4-7).

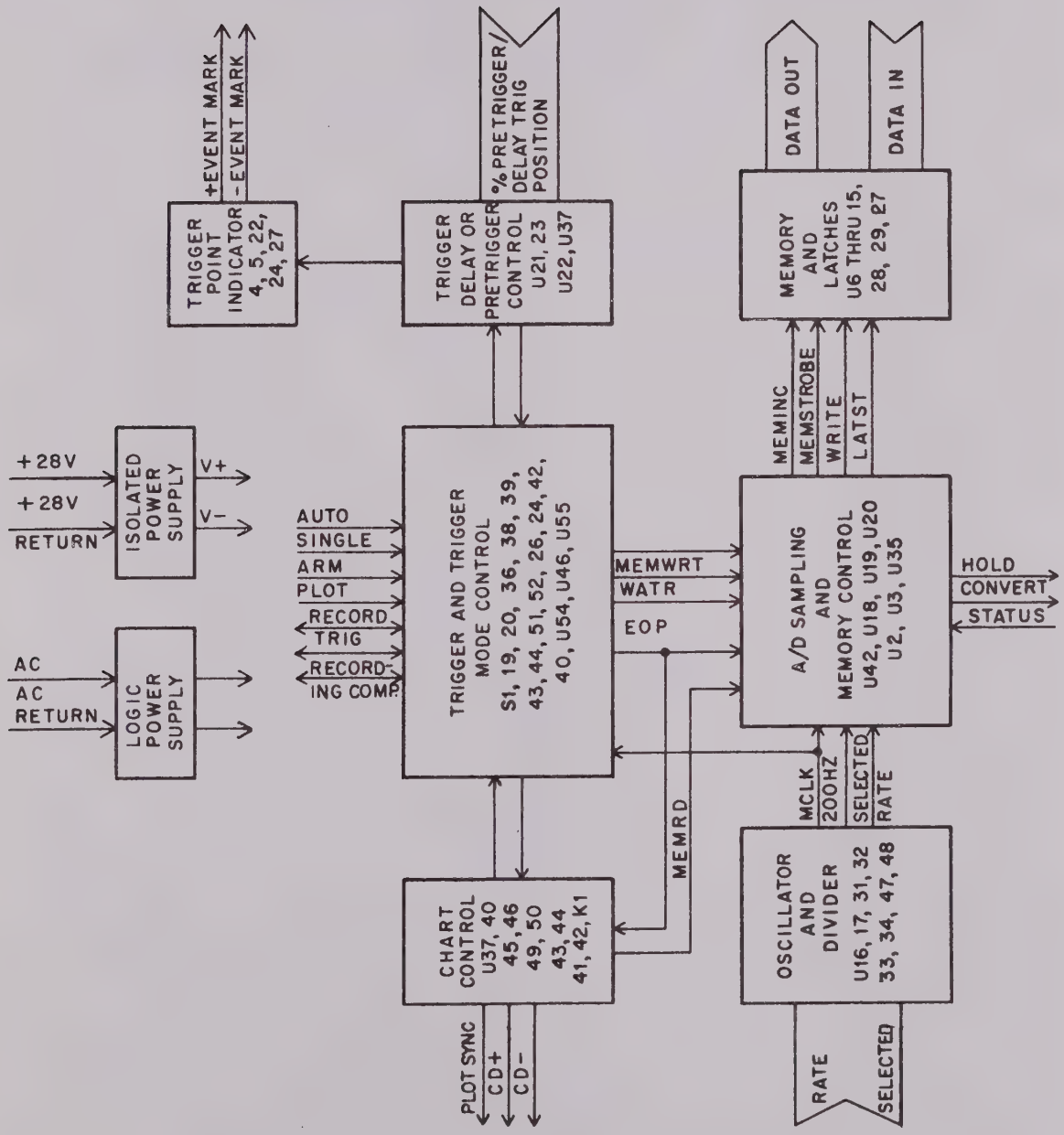


FIGURE 4-5 BLOCK DIAGRAM CONTROL BOARD

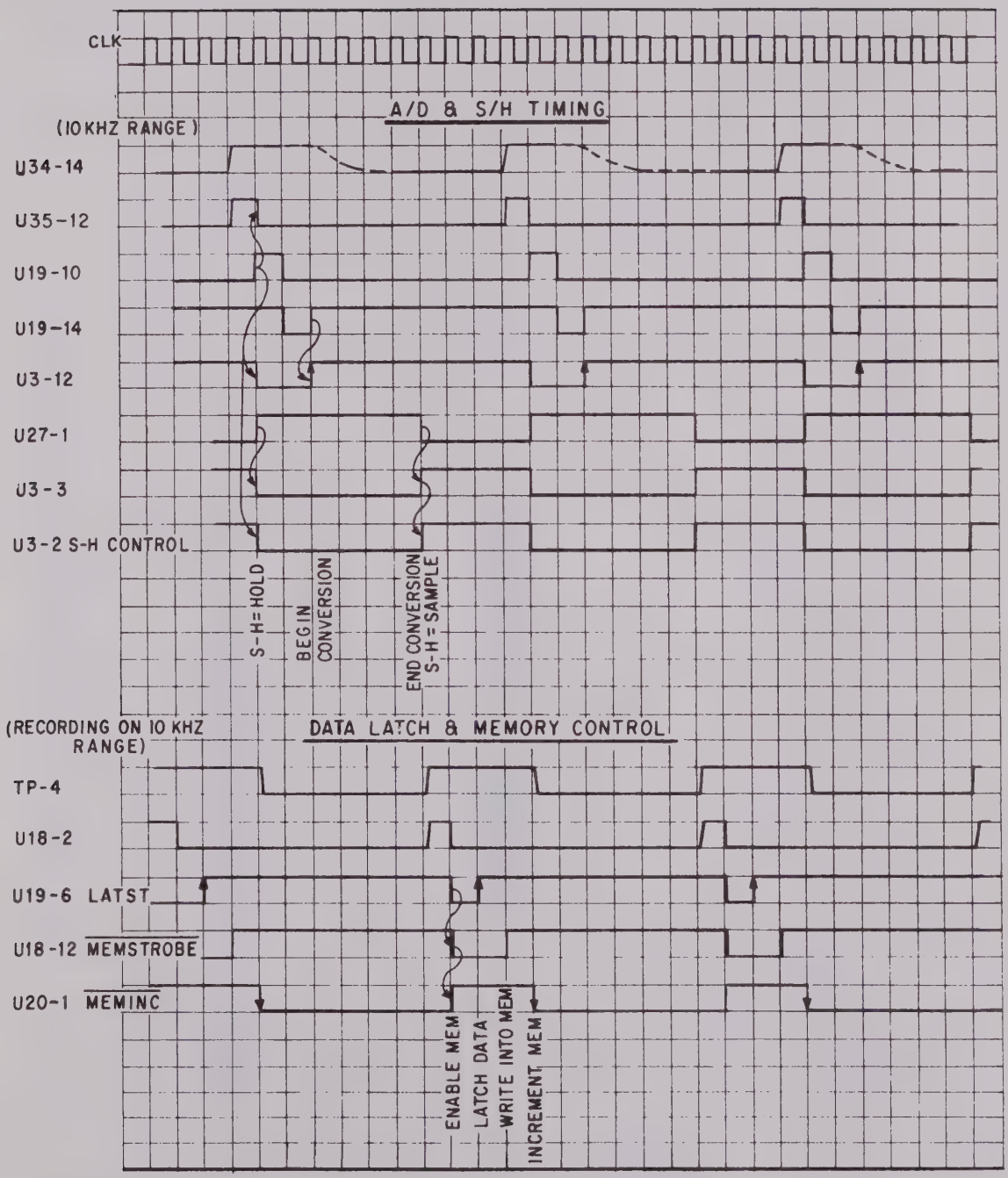


FIGURE 4-6 A/D AND S/H TIMING

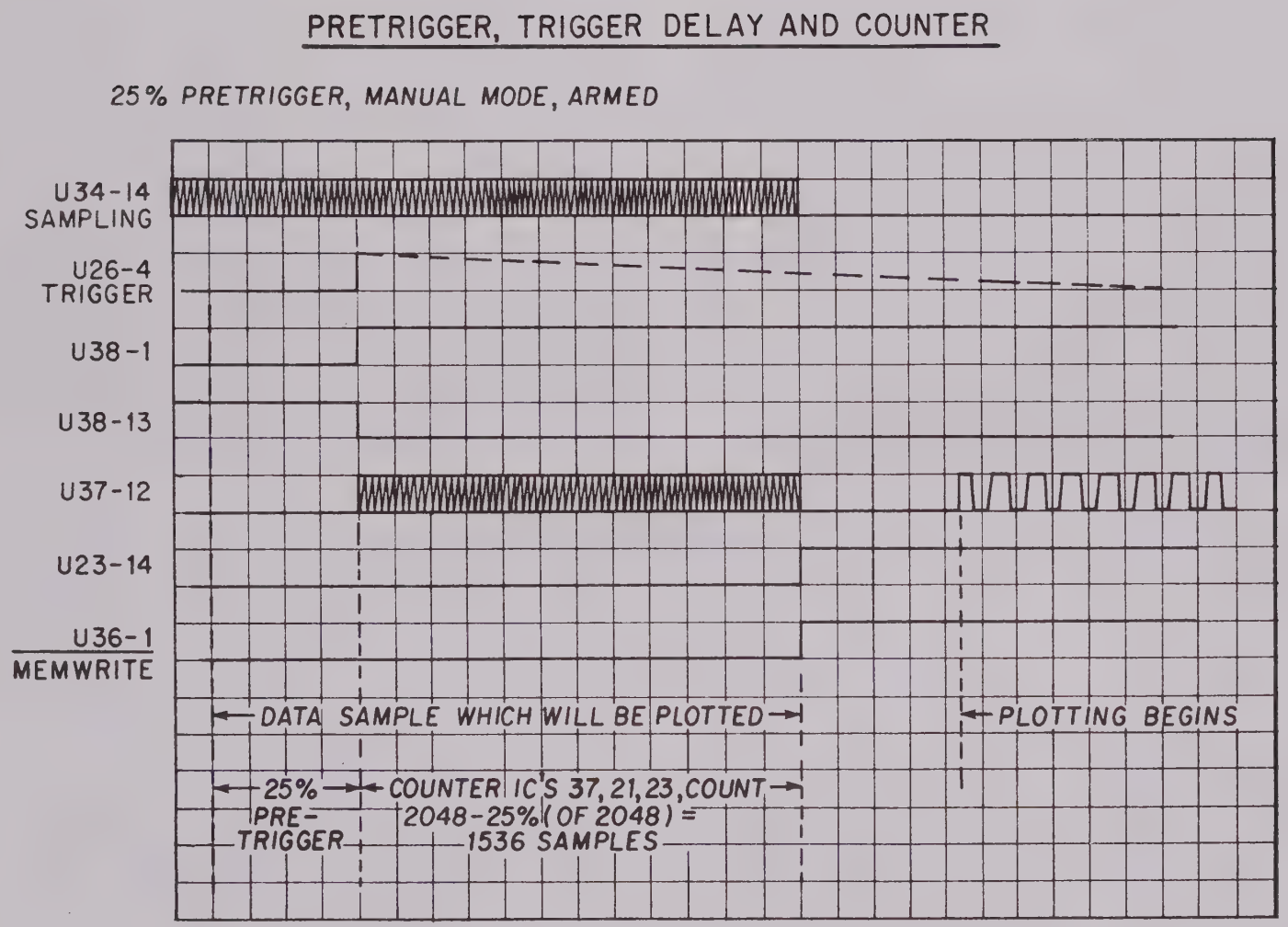


FIGURE 4-7 PRETRIGGER, TRIGGER DELAY AND COUNTER

4.4.6 Chart Control

Still assuming that the unit is a master, the "MEMWRT SIGNAL" falling low will pass through the relay control flip-flop U50. As soon as U50 toggles, the one shot U49 generates a 250 ms pulse to delay plotting until the chart is up to speed. When this pulse finally finishes, U50 toggles and generates the bus signal "PLOT SYNC" via U45 and U46. This is received by U37, generating the memory read "MEMRD" signal. This holds off the trigger resetting and allows U2 to pass a 200Hz signal to the memory control circuit. The memory is continuously read until U1, through W4, causes U20 to toggle, generating an end of plot "EOP" signal. This signal goes back and resets "MEMWRD", "PLOT SYNC", and the relay control flip flops. It also allows retriggering of U51 if selected in auto mode. The "MEMRD" signal in the not true (low) condition also allows U39 to pass the rearming signal through to the "RECORD" optical isolators (U43 and U44) back in the trigger mode control circuitry.

4.4.7 Trigger Point Indicator Control

The trigger point is indicated on the chart when the post-trigger counter (U21) has counted to 1024 (and each 1024 after that). U5 is clocked by the counter (U21) after 1024 counts, and if U22 and U24 do not detect a delay trigger selection (X1, X2, X3 on the front panel) then the Q output of U5 drops low, allowing the other stage of U5 to generate a 200Hz pulse output. This is then fed to U4, a ripple counter, which gives a "-EVENT MRK", followed by a "+EVENT MRK". (Refer to Figure 4-8).

4.4.8 Multiple Waveform Recording Control

There are five signals which are generated on each control board in any system of possibly several waveform recorders, which need to be connected together. Not included in these are isolated power and common. The first is chart drive. This is a pair of signal lines which are connected to the isolated ground lead and the chart recorder to allow the chart to move at the appropriate time (determined by the logic in the waveform preamp). The two lines connect to a relay contact closure or switch closure (Store/Off/Amp), on the front panel to allow current to the chart drive motor relay, thus making the paper move. The other four signals are signal lines which allow the logic of one waveform preamp to interact with the logic of all the other waveform preamps. All four signals use opitcal isolators to keep each channel from interacting with the others. Each signal drives an optical isolator which drives the bus signal out to the other preamps, and also a receiver optical isolator within this preamp.

The first of the four signals is the trigger signal. It has been designed to operate fast, all preamps should not keep sampling if one has received a trigger signal. The driver optical isolator is not strong enough to drive up to 7 other isolators itself, so a transistor network is necessary. The bus signal out active edge, is the falling edge, allowing any waveform preamp on the bus to pull down the trigger bus. Each receiver optical isolator on the bus will then sense a change and forward it to the logic tied to its output. Second and similar is the plot sync signal. It also uses the same principle of operation, that is, the negative edge on the bus activates the logic. However, it does not have to be so fast and the components used will drive up to 7 additional preamps. The plot sync signal signifies that it is time to begin plotting (outputting data to the chart recorder). All preamps will start on the same time line of the chart and all of the points will be truly related in time per the chart time lines. Third is the recording complete signal. This is to allow all preamps which are connected together to have different recording periods (different pretrigger delays and/or different plot time base selections). The operation of this line is that while recording, each preamp will pull the bus line low. When each preamp is done, it allows the line to float high. When all preamps are finally done, no one will be holding the line low and the bus will float high, indicating that all the preamps are done recording new data. The fourth signal, "RECORD', operates the same as recording complete except the function of the line is to remain low until all preamps have been armed (either manually or automatically). When they are all armed, "RECORD" will float high, generating a "WATR" (write and trigger reset) to be issued. Triggers will then be allowed.

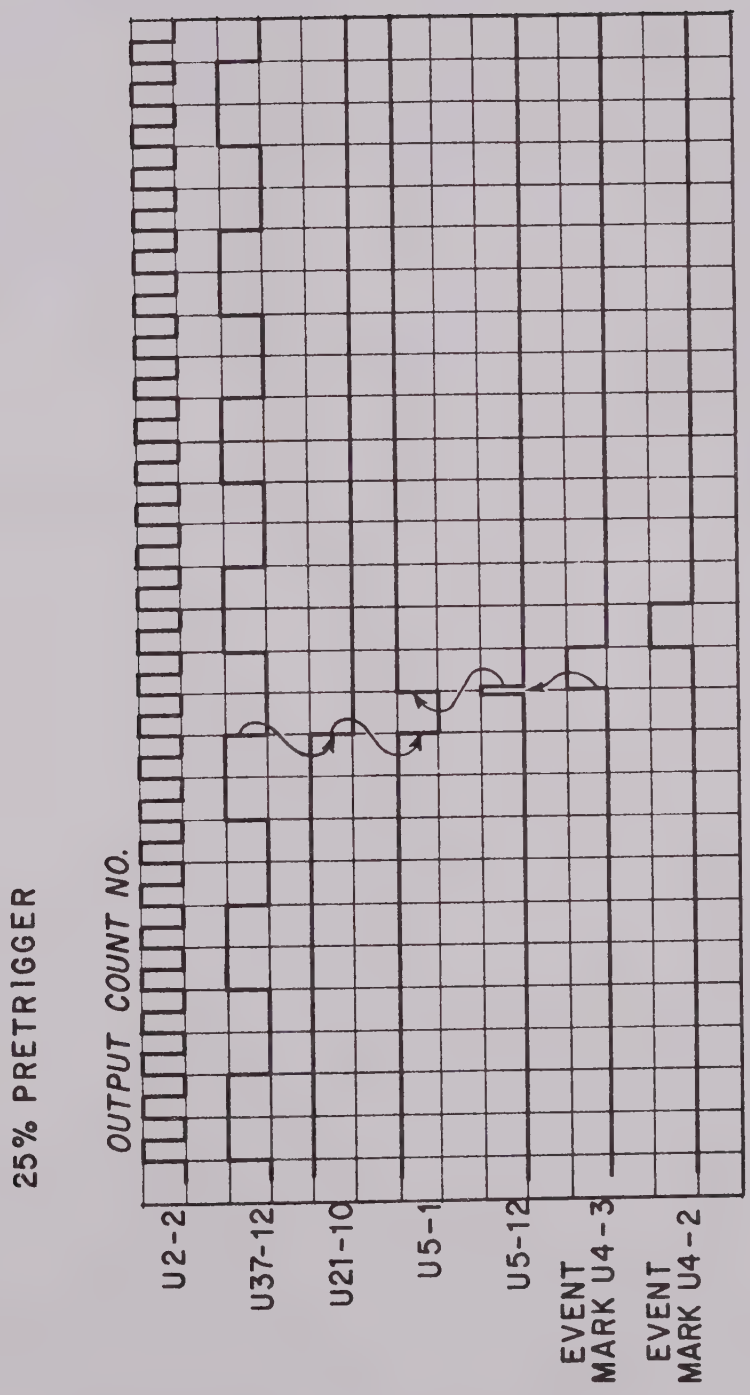


FIGURE 4-8 EVENT MARKER GENERATION

4.4.9 Panel Indicator Control

There are two front panel indicators. A green L.E.D. is connected from the logic supply (through R4) to the Master/Slave switch (S1). If the switch is on, the L.E.D. will pass current to ground and be illuminated, indicating the unit is a master. If the switch is off, the L.E.D.. will be off, indicating the unit is a slave. The second, a red L.E.D., is connected from the logic supply to U41. This red L.E.D. is illuminated when the unit is a master, and when the unit has been armed and is ready to receive a trigger. If the unit is not a master, or if all waveform recorders connected together in a system are not armed, the L.E.D. will not be illuminated. This L.E.D. will go off as soon as a trigger is received.

4.5 POWER SUPPLIES

There are two power supplies on the control board. The first is the +5Vdc logic supply. Twelve volts ac is received from the signal board, rectified by the diode bridge VR1,filtered by C13, and then sent out to the +5V regulator. This regulator is located on the rear panel assy. The regulator output is brought back in and sent all over the board and sent to the signal board as +5Vdc. The bypass capacitors and I.C.'s on the control board are all connected to this supply. The second power supply is the isolated supply. Each waveform recorder operates from its logic supply. However, this supply allows signals to be transferred from one unit to all others. All units must connect to the +28V and to the common, on the rear terminal strip of the chart recorder. Each recorder brings in the +28V and sends it through a diode and dropping resistor before filtering and sending it out to the regulator. The regulator (also mounted on the rear panel assy.) sends back +5Vdc (labeled v+ to V-) for the optical isolators only. This allows the supply in the recorder to be used to join each of the isolated waveform recorder channels.

SECTION V

MAINTENANCE

5.1 INTRODUCTION

In addition to maintenance procedures, this section contains information on calibration and trouble-shooting.

5.2 PREVENTIVE MAINTENANCE

a. General Cleaning

CAUTION

1) BEFORE ATTEMPTING TO CLEAN THE PREAMP, TURN POWER OFF AND REMOVE FROM ENCLOSURE.

2) AVOID USE OF CHEMICAL CLEANING AGENTS WHICH MIGHT DAMAGE PLASTIC OR PRINTED SURFACES. DO NOT USE CHEMICALS WHICH CONTAIN TOLUENE, CELLUSOLVE, ACETONE OR SIMILAR SOLVENTS.

EXTERIOR: Remove loose dust with a soft cloth or small paint brush. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. DO NOT USE ABRASIVE CLEANERS.

INTERIOR: Dust in the interior should be removed occasionally due to its electrical conductivity under high humidity condiitons. Blow off accumulated dust with dry LOW pressure air. Remove any dirt which remains with a soft paint brush or a soft cloth dampened in a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces and/or printed circuit boards.

CAUTION: PREAMPLIFIER MUST BE COMPLETELY DRY BEFORE APPLYING POWER.

5.3 CALIBRATION

a. General

The Gould Waveform Storage Module Amplifier has been accurately calibrated before shipment from the factory, therefore should give long trouble-free service. Should recalibration be required, it should be performed by qualified technical personnel only.

CAUTION: CALIBRATION SHOULD NOT BE ATTEMPTED UNLESS SUITABLE, SPECIFIED TEST EQUIPMENT IS USED.

NOTE: This procedure is broken down into sub-paragraphs by individual adjustments. Under normal conditions, complete calibration should be performed every six months.

b. Equipment Required

The following is a list of test equipment necessary for calibration.

1. Digital Multimeter: AC/DC Keithley Model 172 or equivalent.
2. DC Source: 0.05%
   Accuracy: Digitec 3110 or equivalent.
3. Oscillograph: Gould 2200 or equivalent, with ±15V supplies selected to ± 100mv.
4. Frequency Counter: Balentine 5500A or equivalent.
5. Extender Card: Gould P/N 887291.
6. Waveform Storage Module Test Box (See Figure 5-1). Also refer to Figure 5-1A for parts list.
7. Power Supply: 5Vdc ± 0.25V @ 250 ma.
8. Oscilloscope: Tektronix 7704A with 7A22, 7A26 inputs or equivalent.
9. A.C. Source: Wavetek 142 or equivalent.
10. Second Waveform Storage Module, working properly.
11. Power Supply, RFL 8296 or equivalent.

5.3.1 Mechanical/Visual Check

1. Check assembly for tightness.
2. Check wiring, connections, solder joints, and lead areas.
3. Check front panel for scratches and blemishes.
4. Check silkscreen quality.
5. Check knobs for proper alignment and tightness. Knobs should be spaced approximately .030" off the panel.
6. Operate all front panel controls to assure free motion.

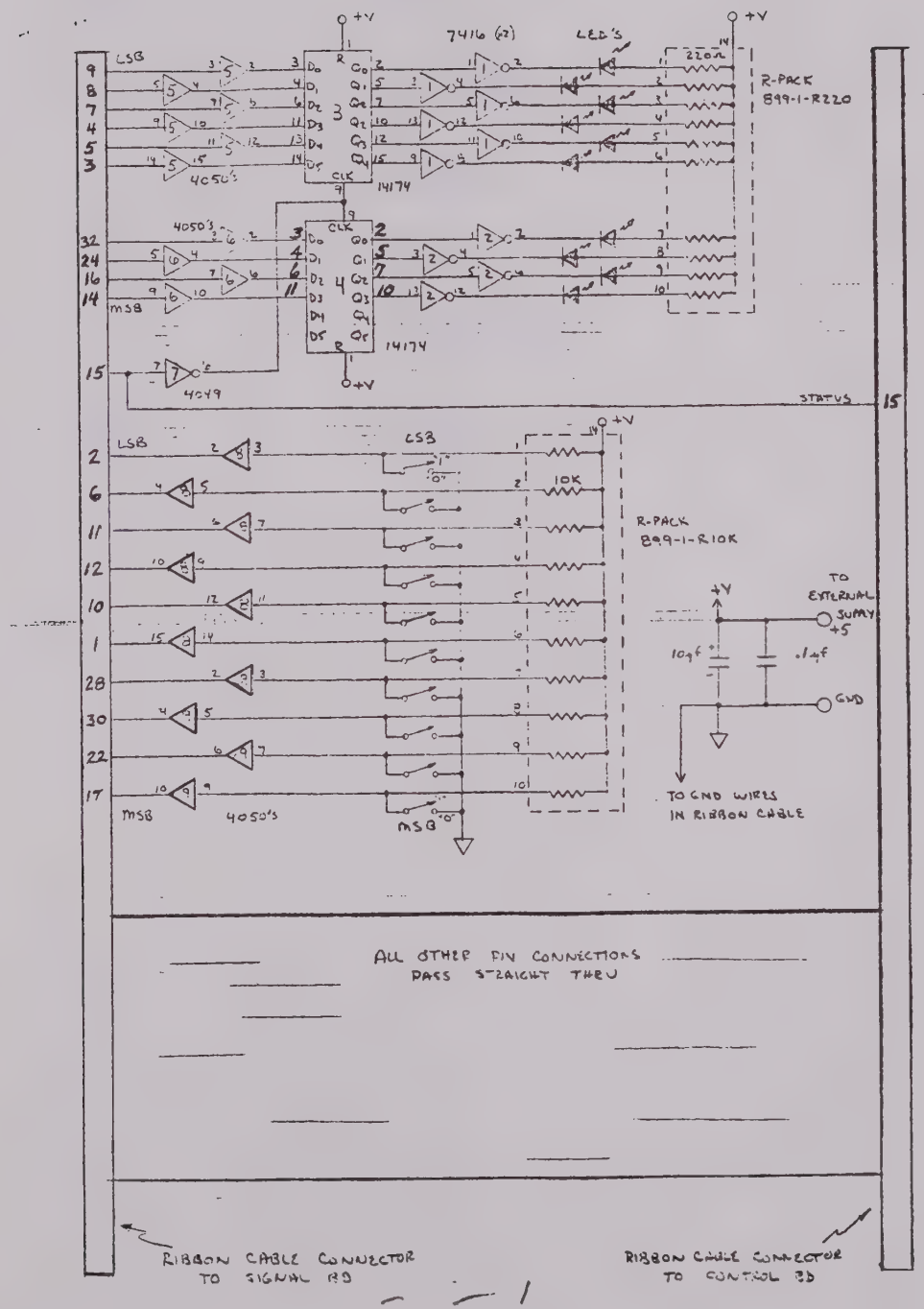


FIGURE 5-1 WAVEFORM TEST BOX SCHEMATIC

W.F.R. CALIBRATION BOX - PARTS LIST

QTY.	PART NUMBER	DESCRIPTION
4		4050
1	290305-049	4049
2	289393	4174
2	285777-1	7416
1	2-283274-221	R-Pack 899-1-R220
1	2-283274-103	R-Pack 899-1-R10K
1	262585-106	10μf/20V
1	288755-104	.1μf/50V
1	126395-2	Binding Post - Red
1	126395-3	Binding Post- Black
10	268923	SPDT Switch
2	291151-50	50 Pin Connector
10		LED's XC556R or equivalent
2 ft.	288070	(External) 50 con. Ribbon Cable
4	1-290318-50	50 Pin Connector

FIGURE 5-1A

5.3.2 Calibration Procedure

NOTE: See Figures 5-2 and 5-3 for printed circuit board adjustments and test point locations.

A. Initial Setup

1. Set the internal Master/Slave Switch (S1) to Master. Refer to Figure 5-2.

2. Check to insure that the wires listed in the list below are placed as indicated. Refer to Figure 5-2.

JUMPER WIRE	POSITION
W1	C-2
W3	Installed
W4	C-2
W6	C-2
W7	Installed

3. Set the front panel controls as follows:

TIME BASE .....10 KHz
INPUT VOLTS FULL SCALE 5.0V
X1-X100..... X1
AMP/OFF/STORE .....AMP
TRIGGER LOW FREQ. REJ.....OFF
% PRETRIGGER 25%
AUTO/MANUAL/ARM .....MANUAL
TRIGGER THRESHOLD ....WINDOW
TRIGGER LEVEL ..... +50%

4. Preliminary Check.

A. Put the left side cover on.

B. Short the (+) and (-) inputs to common.

C. Connect the waveform recorder isolated supply (on the input connector) to a +28V ± 3V supply. Connect +15V ± .10V to pin 4, -15V ±.10V to pin 3, common to pin 1, and 13VAC ± .5VAC to pins 7 and 8 of the signal board recorder connector. Connect the test box to the signal and control boards. Jumper recorder chassis to the waveform chassis and to the control board mounting screw pad area.

Connect a 5Vdc supply to the test box and apply power to the 5V supply. Apply recorder power.

D. Check the following points for proper voltages:

BOARD	FROM	TO	VOLTAGE
Signal	TP11	+End of C27	+15±0.10V
Signal	TP11	−End of C28	−15±0.10V
Control	TP5	TP1	+5±0.25V
Control	TP6	TP2	+5 ±0.25V

B. Control Board

1. Connect the frequency counter from logic ground (TP5) to the master clock (TP3). Adjust C16 to set the frequency (CCW increases frequency) to 1.00000MHz ± 10Hz. Disconnect the frequency counter.

C. Signal Board

1. Short the (+) and (-) inputs to common. Connect the DVM from TP11 (-) to TP1 (+). Set to 0.0V ± 0.0001V with R7.

2. Connect the DVM to TP2. Set to 0.0V ± 0.0001V with R8.

3. Set the VOLTS FULL SCALE switch to 0.1V. Attach the DVM from TP2(+) to TP1(-) and adjust the 0.0V ± 0.0001V with R8.

4. Connect the DVM from TP11 (-) to TP16 (+). Set to 0.0V ± 0.0001V with R9.

5. Set the VOLTS FULL SCALE to 5.0V. Connect the DVM to TP3. Set to 0.0V ± 0.0001V with R120.

6. Check the 5, 2.5, and 1 VOLTS FULL SCALE ranges to insure readings of 0.0V ±0.002V. Check the .5, .25, and .1 VOLT FULL SCALE ranges to have readings of 0.0V ± 0.005V.

7. Set the VOLTS FULL SCALE switch to 5.0V. Connect the DVM to TP4. Set to 0.0V ± 0.0001V with R12.

8. Connect the DVM to TP5. Set to 0.0V ± 0.0001V with R13.

9. Connect the DVM to TP6. Set to 0.0V ± 0.0001V with R3.

10. Set the AMP/OFF/STORE switch in the STORE position. Rotate the front panel trigger level pot fully clockwise. Connect the DVM to TP5. Connect the (+) and (-) input leads to the DC source and apply +4.995V on the DVM.

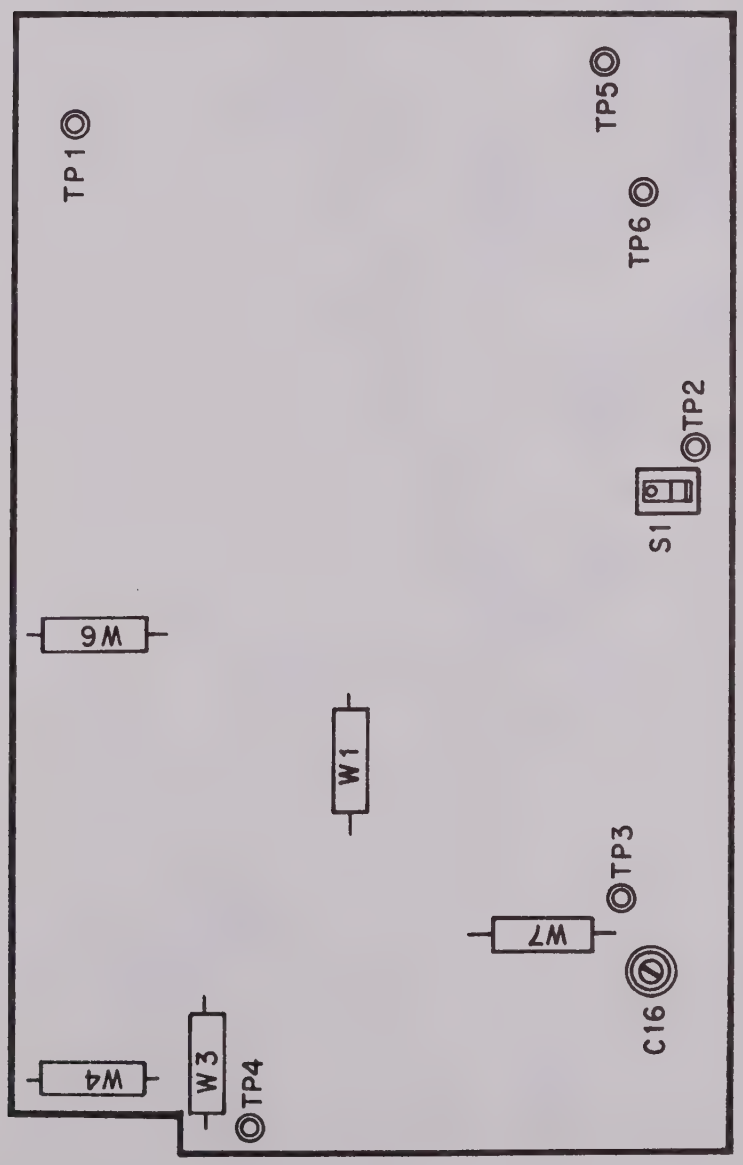


FIGURE 5-2 CONTROL BOARD

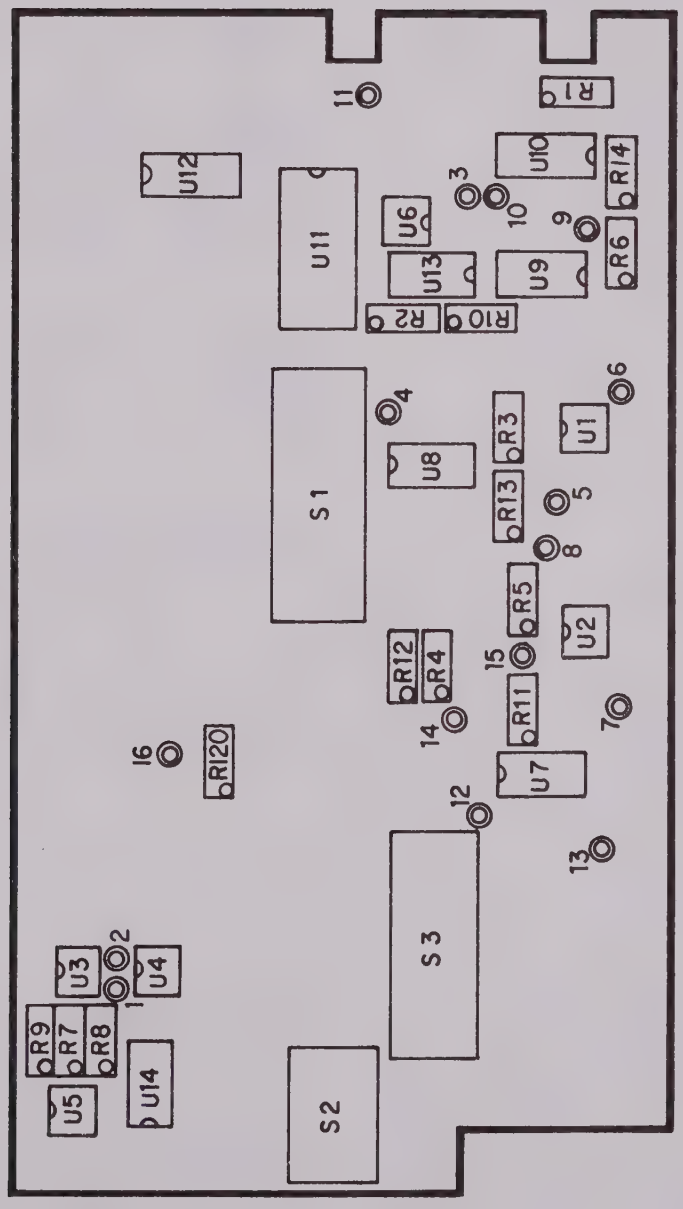


FIGURE 5-3 SIGNAL BOARD

Readjust the source to show -4.995V ± 1mV on the DVM. Set the output of the A/D (via the LEDs on the test box) so that the data bits are on the verge of switching from (MSB) 0000000000 (LSB) to 0000000001 with R10.

(0 = LED off < 0.8 volts and 1 = LED on > 3.0 volts)

11. Set the DC Source input to -4.985 and readjust to show +4.985V on the DVM. Set the output of the A/D so that data bits are on the verge of switching from (MSB) 1111111110 (LSB) to 1111111111 with R2.

12. Apply -1.500V and check the data bits to be (MBS) 10100110XX (LSB). Apply +1.500V and check the data bits to be (MSB) 01011001XX (LSB). (X=LED may be either on or off or flashing).

13. Set the DC source to 0V and check the data bits to be (MSB) 100000000X (LSB). Connect the DVM to TP9. Set to 0.0V ± 0.0001V with R1.

14. Apply a -5 volts on the DVM at TP5. Check the data bits to be (MSB) 000000000X (LSB). Adjust the voltage at TP9 with R6 for a -2.0V ±0.0001V. Insure that the unit is armed.

15. Apply a +5 volts on the DVM at TP5. Check the data bits to be (MSB) 1111111111 (LSB). The output at TP9 should be +2.0V ± .0050V.

16. Set the DVM for 0V at TP5, to achieve data bits of (MSB) 100000000X (LSB). Connect the DVM to TP10. Set to 0V ± 0.0001V with R14.

17. Attach the DVM to TP7. Adjust R5 so that the fully CW position of the front panel TRIGGER LEVEL pot gives a reading of +5.00V ± 5MV. Adjust R4 so that the fully CCW position of the pot gives a reading of -5.00V ± 5MV. Recheck both readings and adjust R5 and R4 as required for the respective readings.

18. Rotate the front panel TRIGGER LEVEL pot to show a reading of 0.00V ± .025V. Adjust the knob on the pot shaft to be pointing to 0%. Check -100% to read -5.00V and check +100% to read +5.00V. Recheck 0.00V to read 0%, and leave control knob at 0%.

19. Attach the DVM to TP8. Temporarily jumper TP7 to TP11 and then adjust R11 for 0.0V ± 0.0001V. Remove the jumper.

20. Turn the power OFF. Disconnect the test box from the control and signal boards. Install the standard cable assembly (694772) between the boards. Remove the external power supplies and chassis jumpers from the unit. This concludes the calibration procedure.

5.4 TROUBLESHOOTING

5.4.1 STAR Diagram Signal Board/Control Board

In order to facilitate troubleshooting of the Gould High Voltage Amplifier, the following Signal Tracing and Replacement (STAR) Diagram is included. A STAR diagram is a block diagram, expanded to include certain wiring diagram information, schematic diagram information and engineering maintenance information (signal levels, waveforms, test points, etc.). Initially, this diagram can be used in conjunction with the Theory of Operation in Section IV of this manual. As service personnel gain familiarity and experience with the equipment, the need to refer to the supporting descriptive text will gradually be eliminated.

The STAR diagram provides the essential information required to isolate a fault to a functional block. To use the STAR diagram, perform the preliminary setup procedure below. Then by applying the scope probe to each test point, proceed through the unit until the signal you obtain is different from the information on the diagram for that test point. Having done this, the block immediately prior to the "bad" test point indicates in which area the trouble lies. Going to that area on the board (and the schematic), components may be checked to find the failure. Be sure to verify that all power supply voltages are present and correct using the following list.

1. Check the following points for proper voltages:

BOARD	FROM	TO	VOLTAGE
Signal	TP11	+End of C27	+15±0.10V
Signal	TP11	-End of C28	-15±0.10V
Control	TP 5	TP1	+5±0.25V
Control	TP6	TP2	+5±0.25V

2. Check the current draw from each supply. The maximum current for each supply is as follows:

SUPPLY VOLTAGE	MAX. CURRENT
+15V	80MA
-15V	80MA
13VAC	175MA
+28V	50MA

5.4.2 STAR Diagram Test

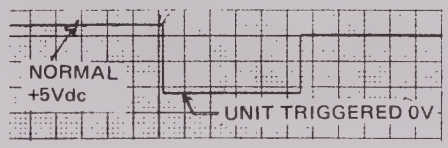
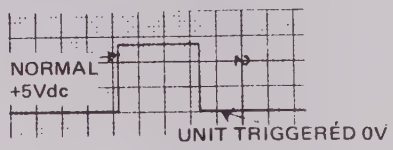
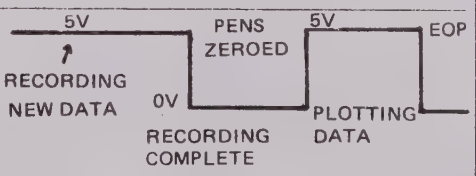
1. Set the front panel controls on the waveform storage module as follows:

TIME BASE 1KHz
INPUTS VOLTS FULL SCALE 5.0V
X1-X100 ..... X1
AMP/OFF/STORE .....STORE
TRIGGER LOW FREQ. REJ. .....OFF
%PRETRIGGER 0%
AUTO/MANUAL/ARM .....MANUAL
TRIGGER THRESHOLD .....WINDOW
TRIGGER LEVEL 50%

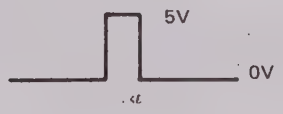
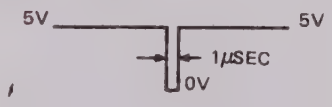
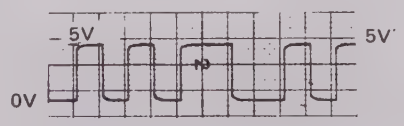
2. Input a 20Hz 4V p-p sine wave to the non-inverting input (yellow wire is positive/shield is ground), or to the inverting input (brown wire is positive/shield is ground), of the waveform storage module.

3. Verify the signals and waveforms on the following pages.

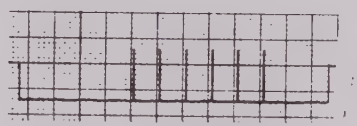
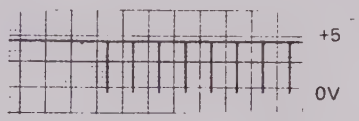
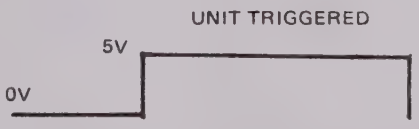
CONTROL BOARD

SIGNAL NAME	LOCATION	NORMAL AMP. FREQUENCY	WAVEFORM
$\overline{\text{PLOT SYNC}}$ Low when Plot Sync.	U46 Pin 2	5V Level	 The falling edge signifies the starting of writing on the chart. The rising edge signifies that writing on the chart has been completed.
RECORD	U44 Pin 2	5V Level	 The rising edge signifies that all units connected together on the system are ready to record new information into memory. The falling edge signifies that the information in memory has been written on the chart.
$\overline{\text{MCLR}}$ Low when memory is clear.	U25 Pin 10	Power OFF 0V Power ON 5V	Clears divider network U47, U17, during initial power up condition, allowing an initial go condition of circuit.
MCLR	U25 Pin 11	A 5V reset pulse during power on	Clears divider networks U32, U16, U33, and the A/D control network U35, and U3. During initial power up, this is a short 5V level.
$\overline{\text{LATCLR}}$ Low when latch clear.	U55 Pin 10	0V Level	 The latch clear effectively zeros the pens on the oscillograph recorder, before actual writing begins. Memory latches U14 and U29 are reset.

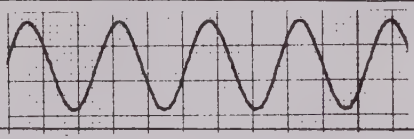
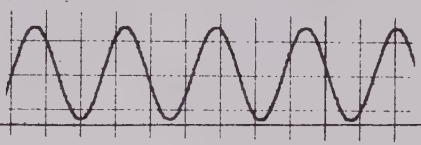
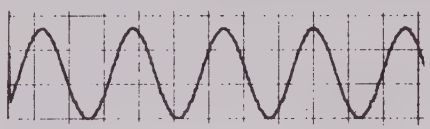
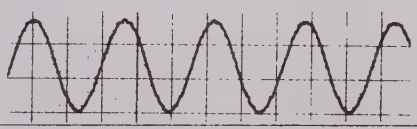
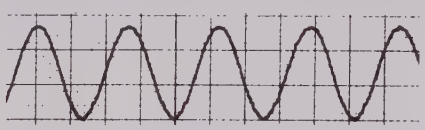
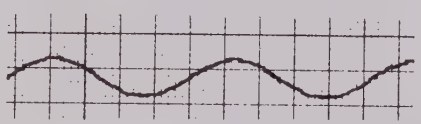
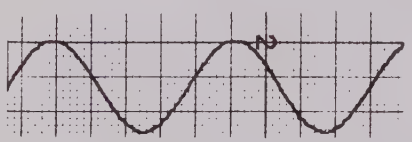
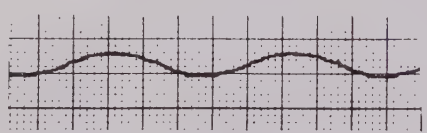
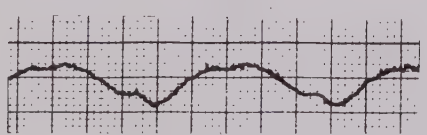
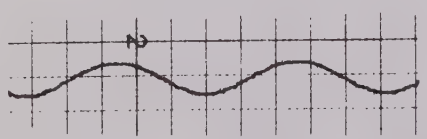
CONTROL BOARD

SIGNAL NAME	LOCATION	NORMAL AMP. FREQUENCY	WAVEFORM
End of Plot EOP	U20 Pin 13	1μsec. 5V pulse	 The 1μsec. pulse is generated at the end of each plot, resetting the following signals: MEMRD (U37-2), PLOT SYNC (U46-2), and Relay Control Flip-Flop (U50). It also allows retriggering via U51 if in the auto mode.
Latch Strobe LATST Unit armed.	U19 Pin 6	1μsec. 0V	 While writing data this signal also allows U14 and U29 to output data. When recording, the "LATST" allows the contents of the A/D to be latched into U14 and U29, to be outputted to the analog pens for real time information. Refer to Figure 4-6.
$\overline{\text{MEMSTROBE}}$ Low when the memory is strobe. Unit armed.	U18 Pin 12	.1msec/cm 5V pulse	 This signal causes the data to be recorded into the memory RAM U8-U13. Refer to Figure 4-6.
MCLK Master Clock	U48 Pin 6	1MHz 5V	 Inverter I.C. U48 generates the Master Clock trimmable to 1MHz exactly.

CONTROL BOARD

SIGNAL NAME	LOCATION	NORMAL AMP. FREQUENCY	WAVEFORM
MEMWRT	U36 Pin 1		 This signal is caused to go high by the "WATR" signal. This signal falling low will pass through the relay control flip-flop U50. As soon as U50 toggles, the one shot U49 generates a 250 ms pulse to delay plotting until the chart is up to speed.
$\overline{\text{MEMINC}}$ Low when the memory is incremented. Unit armed.	U20 Pin 1	3μsec pulse	 THE MEMORY IS INCREMENTED ON THE FALLING EDGE. These 3μsec negative going pulses increment the memory. Refer to Figure 4-6.
Conversion Complete	U27 Pin 2	1μsec 0V	 When the A/D is finished, it drops the status line to a low state, generating a conversion complete. While recording new data, this conversion complete signal causes the memory control circuit to generate pulses to the "LATST", MEMST, and MEMINC. Refer to Figure 4-6.
MEMRD Memory Read	U37 Pin 2		 This signal is high during the time when information is being read out of memory to the pens for plotting.

SIGNAL BOARD

WAVEFORM	AMPTD FREQ	TEST POINT	SWEEP SPEED	VERT. SENS.	TRIGGER MODE	TRIGGER POL	TRIGGER CPLG	INPUT SIGNAL
	4V p-p 60Hz	2 Non-inverting	5ms/ cm	X10 probe .2V/cm	Normal	+	DC	4V p-p Sine wave 20Hz
	4V p-p 20Hz	3	20ms/ cm	X10 probe .2V/cm	Normal	+	DC	4V p-p Sine wave 20Hz
	4V p-p 20Hz	4	20ms/ cm	X10 probe .2V/cm	Normal	+	DC	4V p-p Sine wave 20Hz
	4V p-p 20Hz	5	20ms/ cm	X10 probe .2V/cm	Normal	+	DC	4V p-p Sine wave 20Hz
	4V p-p 20Hz	6	20ms/ cm	X10 probe .2V/cm	Normal	+	DC	4V p-p Sine wave 20Hz
	2V p-p 4Hz	9	50ms/ cm	X10 .2V/cm	Normal	+	DC	4V p-p Sine wave 20Hz
	4V p-p 4Hz	10	50ms/ cm	X10 probe .2V/cm	Normal	+	DC	4V p-p Sine wave 20Hz
	2V p-p 20Hz	12	10ms/ cm	X10 probe .2V/cm	Normal	+	DC	4V p-p Sine wave 20Hz
	.1V p-p 20Hz	13	10ms/ cm	X10 probe 10mv/ cm	Normal	+	DC	4V p-p Sine wave 20Hz
	1.6V p-p 20Hz	16	10ms/ cm	X10 probe .2V/cm	Normal	+	DC	4V p-p 20Hz

SECTION VI

PARTS IDENTIFICATION

6.1 GENERAL

This instrument has been accurately calibrated and adjusted before shipment from the factory and should give long, trouble-free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Gould Service Engineer listed on the warranty card shipped with the instrument.

The following parts lists and schematic diagrams are designed to assist in servicing and repairing the instrument.

NOTE: Check to be sure the schematic number and revision letter stamped on the rear of the instrument agree with the number and revision letter on the schematic contained in this section.

To assure prompt and satisfactory delivery of replacement parts, include the following with the purchase order:

1. Name, model number, and serial number of the instrument.

   For Example: Waveform Storage Amplifier, Model 13-4616-10, Serial Number_____.

2. Description of the part as listed in the manual.

3. Gould part number.

NOTE: Do not use the SYMBOL NUMBER from the parts list for identifying desired parts on the order.

†Denotes item is not procurable.

EXPLODED VIEW PARTS LIST
WAVEFORM STORAGE AMPLIFIER MODEL 13-4616-10
FIGURE 6-1

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
1	285651-12	Knob	
2	694245	Knob Assy, Locking	
3	1-294866-2	Cap	
4	285652-5	Knob	
5	794776	Panel Assy, Silkscreen (A-P)	
	31-119998-26	Nut, Hex	
	8-120052-101	Lockwasher	
		------*------	
6	289397-1	LED, Green	
7	393596	Panel, Sub (A-P)	
	13-262715-4004	Screw	
		------*------	
	686421	Cover Assy	
8			
9			
10	685944-1	Frame	
11	694370	Panel Bearing Assy (A-P)	
	1-120052-209	Lockwasher	
		------*------	
	795136	Shaft Assy, Drive	
12	245203-4002	Screw, Set	
13	240161-214	Pin	
14	295134	Clevis	
15	295135	Block, Joint	
16	295133	Link, Drive	
	794773	Harness Assy (A-P)	
	663800-1	Nut, Knurled	
		------*------	
17	269960	Switch, Toggle DPDT	S101
18	287489	Key, Polarizing	
19	287491-7	Connector	P6 - P7
20	1-287490	Contact, Elect	
	894774	Harness Assy (A-P)	
	663800-1	Nut, Knurled	
		------*------	
21	287491-2	Connector	P11 - P12
22	1-287490	Contact, Elect	
23	291996-1	Switch, Toggle 4P3T	S102
24	230079	Switch, Toggle DP3 T	S106
25	294788	Switch, Rotary	
26	294865	Switch, Pushbutton	S105
27	269093	Switch, Toggle DP3T	S104
28	287491-7	Connector	P8
29	287491-12	Connector	J4
30	287491-10	Connector	J1

EXPLODED VIEW PARTS LIST
WAVEFORM STORAGE AMPLIFIER MODEL 13-4616-10
FIGURE 6-1 (Continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
31	287489	Key, Polarizing	
32	232997-23	Strap, Retaining	
	694775	Harness Assy (A-P)	
	1-293279-1	Nut	
		------*------	
33		Resistor, Variable 10K	R101
34	1-287490	Contact, Elect	
35	287491-4	Connector	P9
36	287489	Key, Polarizing	
37	289396	LED, Red	
38	240935	Bushing (A-P)	
	11-106755-4	Nut, Hex	
		------*------	
39	894777	Panel Assy, Rear (A-P)	
	13-262716-4004	Screw, Pan Hd.	
		------*------	
40	894706	Board Assy, Signal (A-P)	
	13-262716-4004	Screw, Pan Hd.	
		------*------	
41	694772	Cable Assy	
42	894705	Board Assy, Control (A-P)	
	31-119918-4008	Screw, Mach.. Pan Hd.	
	8-120052-103	Lockwasher	
		------*------	
43	285943	Cover, Side	

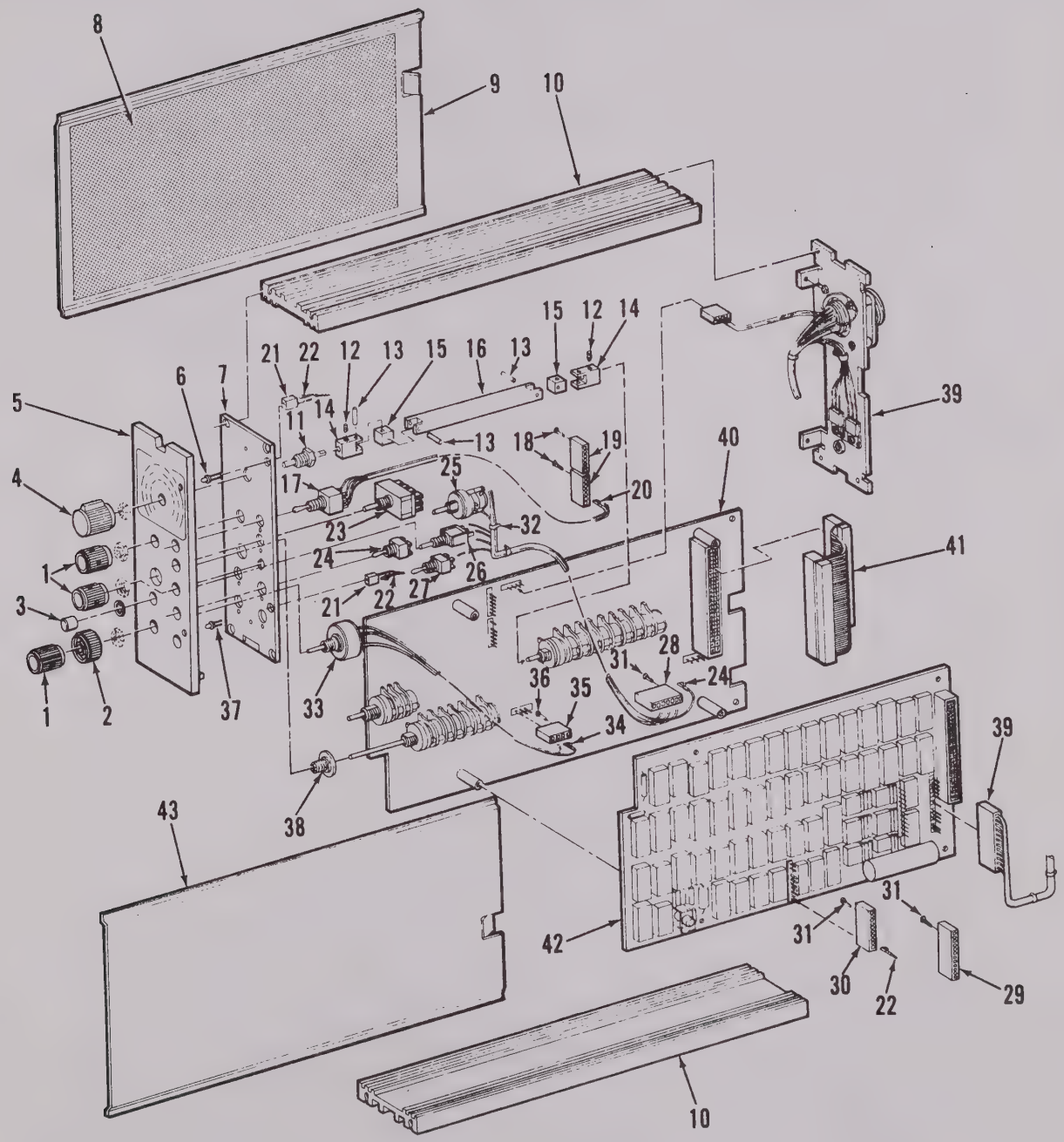


FIGURE 6-1 WAVEFORM STORAGE MODULE

EXPLODED VIEW PARTS LIST
PANEL ASSY. REAR 894777
FIGURE 6-2

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
1	266917-1	Spacer	
2	795382	Panel, Rear	
3	293848-3	Insulator	
4	292900	Kit, Insulation (A-P)	
	13-262716-4004	Screw, Self-Tapping	
		------*------	
5	293848-4	Clamp (A-P)	
	13-262716-4004	Screw, Self-Tapping	
	1-118195-304	Washer, Flat	
		------*------	
	893980	Connector Assy (A-P)	
	31-119918-4012	Screw, Mach. Pan Hd.	
	243898-40	Nut	
	1-216741-411	Lockwasher	
		------*------	
6	285317	Regulator, 5V 7805	U101, U102
7	1-287490	Contact, Elect	
8	287491-15	Connector	P2
9	287489	Key, Polarizing	
10	287491-5	Connector	P10
11	1-290155-2	Contact, Elect	
12	103097-6	Lug	
13	295344	Connector	
14	232997-23	Strap, Retaining	

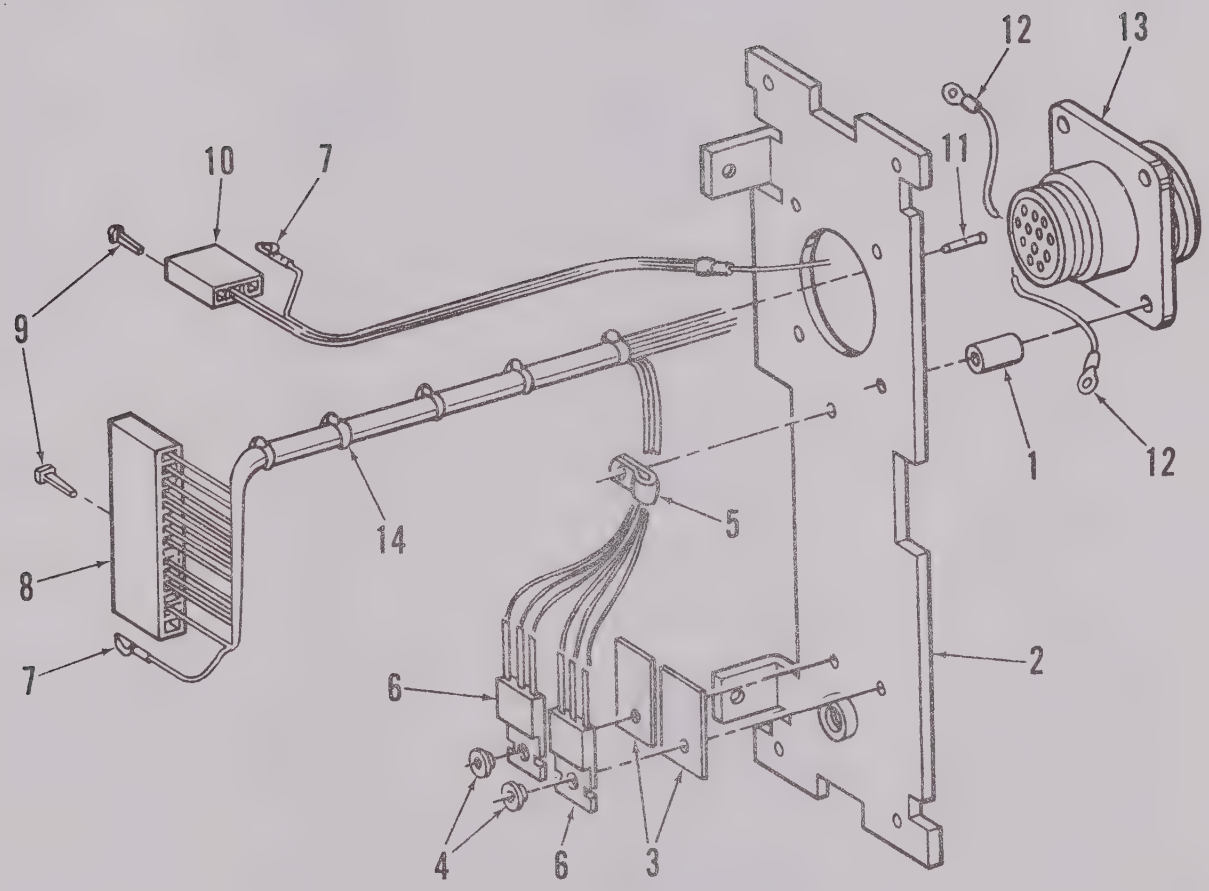


FIGURE 6-2 REAR PANEL ASSEMBLY

ELECTRONIC PARTS LIST
BOARD ASSEMBLY 894705
FIGURE 6-3

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C1, C7	243006-205	Capacitor 2μf/50V
C2, C5, C8, C10	288755-104	Capacitor .1μf/50V
C11, C12, C17	288755-104	Capacitor .1μf/50V
C3, C6	262956-226	Capacitor 22μf/10V
C4, C18	290091-103	Capacitor .01μf/1Kv
C9	10-263694-686	Capacitor 68μf/25V
C13	294666-477	Capacitor 470μf/35V
C14, C15	262585-106	Capacitor 10μf/20V
C16	294797-1	Variable Capacitor 1 - 9 PF
C19	10-288757-221	Capacitor 220 PF/20V
C20	10-288757-100	Capacitor 10 PF/50V
C21 - C36	288755-103	Capacitor .01μf/50V
CR1	269256-5	Diode IN4005
CR2	289662-	Diode IN914
J1	1-287495-10	Connector
J2	1-287495-15	Connector
J3	291151-50	Connector
J4	287495	Connector
K1	293735-3	Relay
Q1	263901	Transistor 2N3645
R1, R6, R18, R19	5-241111-202	Resistor 2Kohms
R2, R7, R17	5-241111-362	Resistor 3.6Kohms
R3, R9, R11, R16	5-241111-472	Resistor 4.7Kohms
R8, R20, R21, R24	5-241111-103	Resistor 10Kohms
R10	5-115558-271	Resistor 270 ohms
R13	5-241111-302	Resistor 3.0Kohms
R4, R5, R12	5-241111-301	Resistor 300 ohms
R14	5-241111-182	Resistor 1.8Kohms
R15	5-241111-391	Resistor 390 ohms
R22	5-241111-101	Resistor 100 ohms
R23	5-241111-102	Resistor 1.0Kohms
R25, R26	5-241111-473	Resistor 47Kohms
S1	293857	Switch
TP1, TP6	265763-3	Contact
U1, U21	290305-020	I.C. 14020
U2, U52	284684	I.C. 4011
U3, U5, U18	284681	I.C. 4013
U20, U33, U35	284681	I.C. 4013
U38, U50, U51	284681	I.C. 4013

ELECTRONIC PARTS LIST
BOARD ASSEMBLY 894705
FIGURE 6-3 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
U4	284691	I.C. 4017
U6	290305-556	I.C. 14556
U7	284438	I.C. 4040
U8 - U13	294667	I.C. HM6514
U14, U29	290305-174	I.C. 14174
U16, U32	290305-518	I.C. 14518
U17, U47	290305-161	I.C. 14161
U15, U28	291239	I.C. 80C97
U19	290305-175	I.C. 14175
U22, U26, U40	290305-081	I.C.. 14081
U23, U34	290305-512	I.C. 14512
U24	290305-071	I.C. 14071
U25, U27, U48	290305-069	I.C. 14069
U31	290305-532	I.C. 14532
U39	284683	I.C. 4001
U41	288498	I.C. 74L504
U42	285302	I.C. 4049
U43, U44, U46	294674-1	Opto Isolator HCPL-2731
U45	294668-1	Opto Isolator 6N139
U49	291237	I.C. 74C221
U30, U53	2-283274-103	Resistor Network 10Kohms
U54	294670	Opto Isolator HCPL-2601
U55	290305-070	I.C. 14070
VR1	291758-2	Bridge Rectifier VM18
W1, W2, W3	267235	Jumper
W4, W5, W6, W7	267235	Jumper
Y1	289053-9	Crystal 1MHz

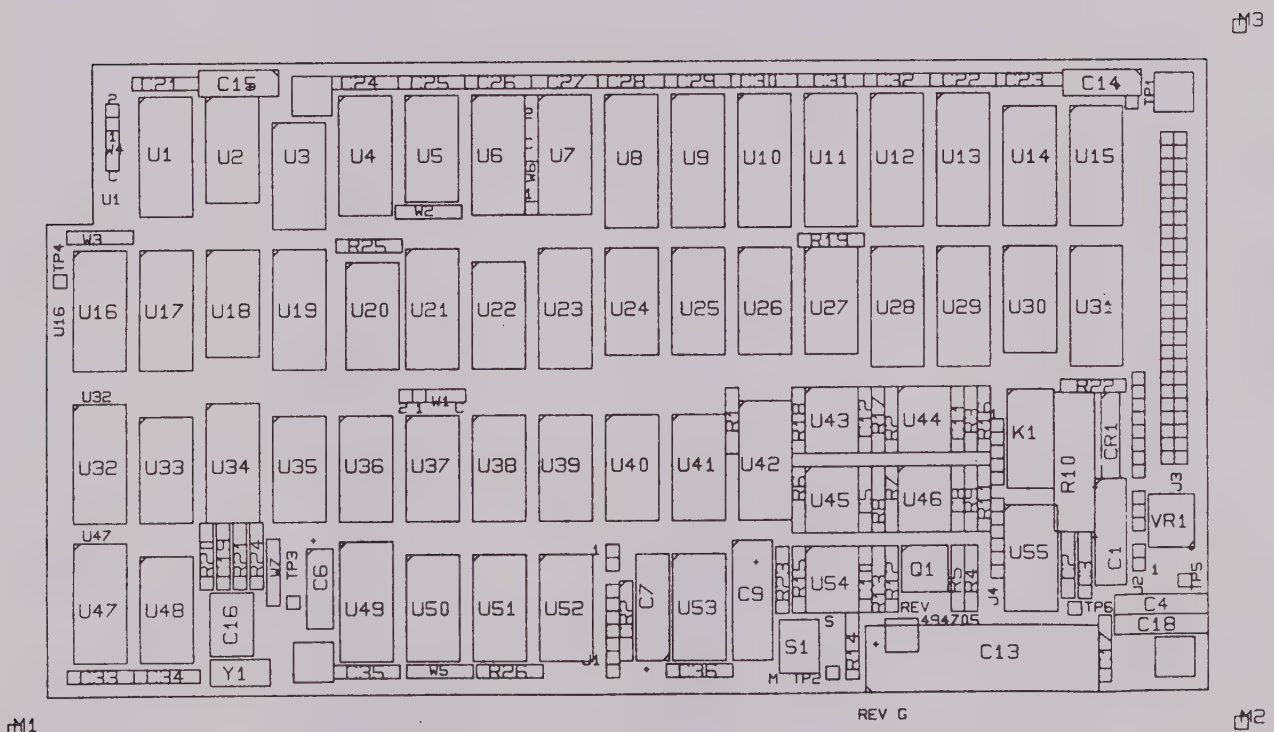


FIGURE 6-3 CONTROL BOARD

ELECTRONIC PARTS LIST
BOARD ASSEMBLY 894706
FIGURE 6-4

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C1 - C20	288755-104	Capacitor .1μf/50V
C21 - C23	10-288757-100	Capacitor 10μf/50V
C24	290091-103	Capacitor .01μf/1Kv
C25, C26	20-263695-105	Capacitor 1μf/20V
C27, C28	243006-106	Capacitor 10μf/50V
C29, C32	294678-102	Capacitor .001μf/50V
C33	294679-202	Capacitor .002μf/125V
C34, C35	294678-472	Capacitor .0047μf/50V
C36 - C44	294678-103	Capacitor .01μf/50V
C45, C46	294677-473	Capacitor .047 μf/25V
C47 - C50	294677-104	Capacitor .1μf/25V
C51, C52	287614-821	Capacitor 820 PF/50V
CR1 - CR4	288072-	Diode 1N3595
CR5, CR6	289662	Diode 1N914
CR7, CR8	283166-1	Diode 1N4576
J5	291151-50	Connector
J6 - J8	1-287495-7	Connector
J9	1-287495-4	Connector
J10	1-287495-5	Connector
R1	269085-500	Resistor, Variable 50 ohms
R2, R10	269085-101	Resistor, Variable 100 ohms
R3	259085-102	Resistor, Variable 1Kohm
R4 - R6	269085-202	Resistor, Variable 2Kohms
R7 - R9	269085-103	Resistor, Variable 10Kohms
R11 - R14, R20	269085-503	Resistor, Variable 50Kohms
R15, R16	5-115557-105	Resistor 1Megohm
R17, R18	286685-10003	Resistor 1Megohm
R19	1-281851-20000	Resistor 2Kohms
R20	R1-288308-29100	Resistor 75Kohms
R21	5-241111-243	Resistor 24Kohms
R22, R23	5-115558-104	Resistor 100Kohms
R24, R25	R1-288308-20000	Resistor 2Kohms
R26	R1-288308-29100	Resistor 2.91Kohms
R27	R1-288308-30000	Resistor 3Kohms
R28, R29	R1-288308-75000	Resistor 7.5Kohms
R30, R31	R1-288308-80000	Resistor 8Kohms
R32 - R39	R1-288308-10001	Resistor 10Kohms
R40, R41	R1-288308-10101	Resistor 10.1Kohms
R42, R43	R1-288308-19801	Resistor 19.8Kohms
R44 - R46	R1-288308-20001	Resistor 20Kohms
R47 - R50	R1-288308-30001	Resistor 30Kohms

ELECTRONIC PARTS LIST
BOARD ASSEMBLY 894706
FIGURE 6-4 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R51	1-281851-100R0	Resistor 100 ohms
R52	1-281851-130R0	Resistor 130 ohms
R53, R54	1-281851-200R0	Resistor 200 ohms
R55	1-281851-787R0	Resistor 787 ohms
R56	1-281851-16200	Resistor 1.62Kohms
R57	1-281851-17800	Resistor 1.78Kohms
R58, R59	1-281851-20500	Resistor 2.05Kohms
R60	1-281851-	Resistor 3.09Kohms
R61	1-281851-44200	Resistor 4.42Kohms
R62	1-281851-45300	Resistor 4.53Kohms
R63	1-281851-48700	Resistor 4.87Kohms
R64 - R65	1-281851-50000	Resistor 5.0Kohms
R67	1-281851-51100	Resistor 5.11Kohms
R68	1-281851-68100	Resistor 6.81Kohms
R69	1-281851-78700	Resistor 7.87Kohms
R70	1-281851-80600	Resistor 8.06Kohms
R71	1-281851-82500	Resistor 8.25Kohms
R72	1-281851-88700	Resistor 8.87Kohms
R73, R74	5-241111-242	Resistor 2.4Kohms
R75	1-281851-10201	Resistor 10.2Kohms
R76	1-281851-11301	Resistor 11.3Kohms
R77	1-281851-11501	Resistor 11.5Kohms
R78	1-281851-15401	Resistor 15.4Kohms
R79	1-281851-17801	Resistor 17.8Kohms
R80 - R82	1-281851-20001	Resistor 20Kohms
R83	1-281851-20501	Resistor 20.5Kohms
R84	1-281851-21501	Resistor 21.5Kohms
R85	1-281851-30001	Resistor 30Kohms
R86	1-281851-30901	Resistor 30.9Kohms
R87	1-281851-34001	Resistor 34Kohms
R88	1-281851-36501	Resistor 36.5Kohms
R89	1-281851-48701	Resistor 48.7Kohms
R90 - R92	1-281851-50001	Resistor 50Kohms
R93	1-281851-51101	Resistor 51.1Kohms
R94	1-281851-61901	Resistor 61.9Kohms
R95	1-281851-78701	Resistor 78.7Kohms
R96	1-281851-84501	Resistor 84.5Kohms
R97, R98	1-281851-97602	Resistor 97.6Kohms
R99, R100	1-281851-10002	Resistor 100Kohms
R101	1-281851-10202	Resistor 102Kohms
R102	1-281851-12402	Resistor 124Kohms

ELECTRONIC PARTS LIST
BOARD ASSEMBLY 894706
FIGURE 6-4 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R103, R104, R119	1-281851-15002	Resistor 150Kohms
R105	1-281851-15402	Resistor 154Kohms
R106	1-281851-16502	Resistor 165Kohms
R107	1-281851-16902	Resistor 169Kohms
R117	1-294868-28000	Resistor 2.8Kohms
R108	1-294868-20502	Resistor 205Kohms
R109, R110	1-294868-22602	Resistor 226Kohms
R111, R112	1-294868-30902	Resistor 309Kohms
R113	1-294868-34002	Resistor 340Kohms
R114	1-294868-46402	Resistor 464Kohms
R115, R116	1-294868-30003	Resistor 3Megohms
R118	1-294868-90R90	Resistor 90.9 ohms
S1	294782	Switch
S2	294781	Switch
S3	294680	Switch
TP1 - TP6	265763-3	Contact
U1	294783-1	I.C. NE5537-H
U2	294786-1	I.C. LM393
U3 - U5	292885	I.C. LF351
U6	294785	I.C. IH5020
U7, U8	294784-1	I.C. LF347
U9	292719	I.C. OP11EY
U10	294669-1	I.C. AD561
U11	294671-2	I.C. AD578
U12	2-283274-682	Resistor Network 6.8Kohms
U13	4-283274-823	Resistor Network 82Kohms
U14	2-294864-103	Resistor Network 10Kohms
W1	267235	Jumper

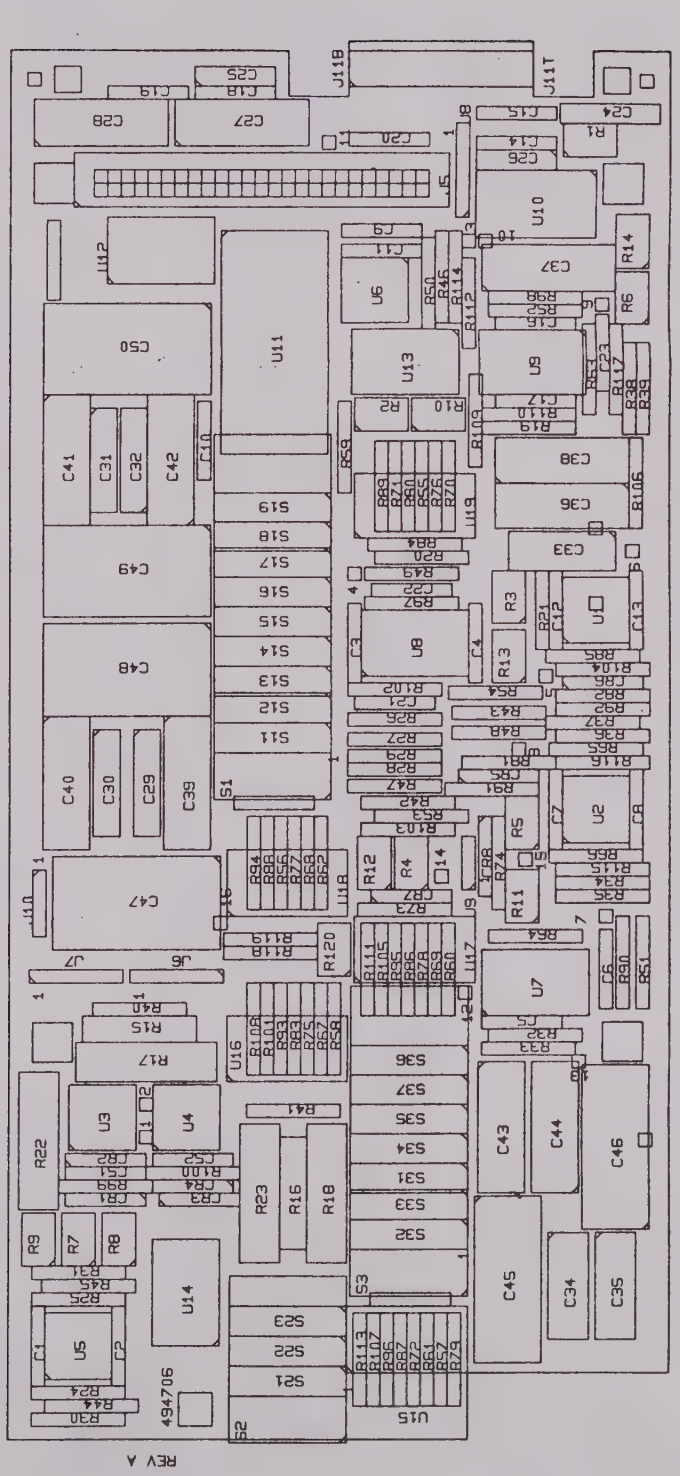
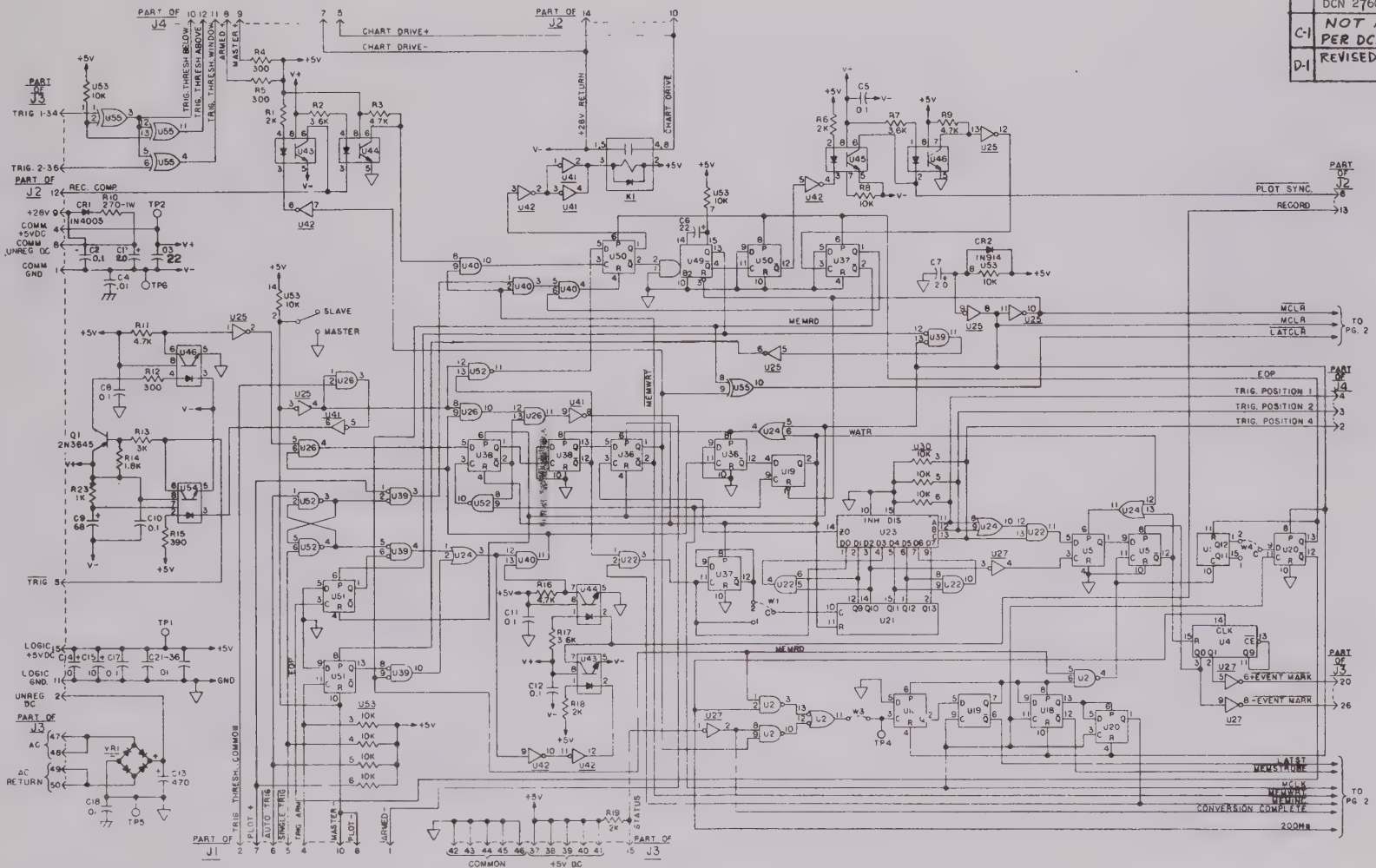


FIGURE 6-4 SIGNAL BOARD 894706



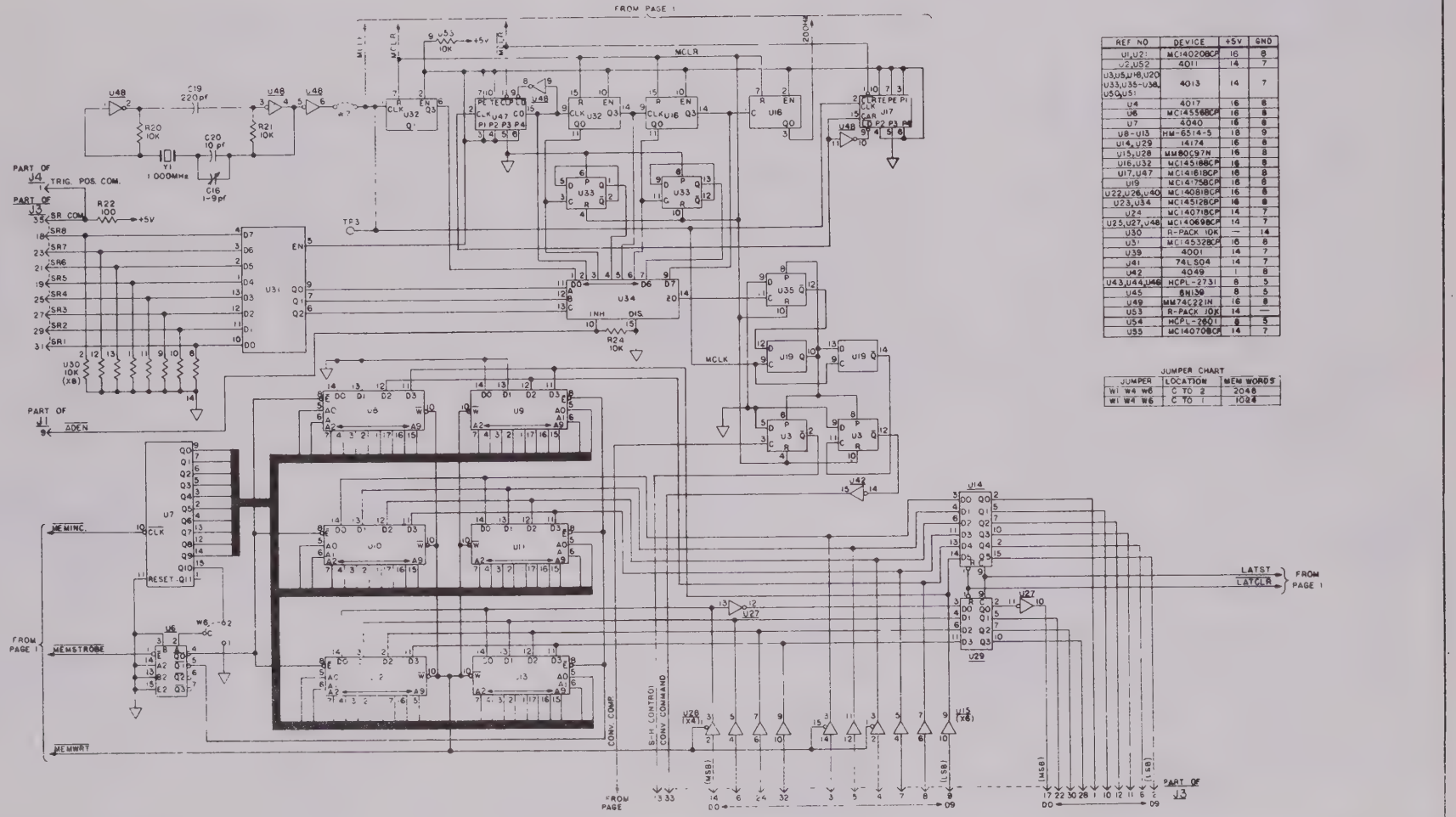
REVISIONS		
SYM	DESCRIPTION	DATE
A	REVISED PER DCN27337	11-24-
B-1	CAPCITOR C3 WAS: 0.1MF DCN 27606/S. JONES	2-12-81
C-1	NOT AFFECTED PER DCN 27679/COMELLA	2-19-81
D-1	REVISED PER DCN 27951 J.COMELLA	4-6-81

4. ALL UNUSED GATE INPUTS GROUNDED.
3. RESISTOR TOLERANCE: B= 0.25%, C= 0.1%, F=1.0%
2. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ± 5% 1/4 WATT.
1. UNLESS OTHERWISE SPECIFIED, ALL CAPACITORS ARE MICROFARADS, ALL RESISTORS IN OHMS.

NOTES:

BOARD ASSEMBLY, CONTROL, 894705

BY	DATE	NAME	SCHEMATIC	Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A.
DR. T. CLARK	12/5/80			
CH.	2/8			DWG. NO. 894705
		CODE IDENT 96795	ISSUE CODE G	PAGE 1 OF 2



REVISIONS

BY	DESCRIPTION	DATE

REF NO	DEVICE	+5V	GND
U1,U2	MC14020BCP	16	8
U2,U52	4011	14	7
U3,U5,U18,U20 U33,U35-U38, U50,U51	4013	14	7
U4	4017	16	8
U6	MC14534BCP	16	8
U7	4040	16	8
U8-U13	HM-6514-5	18	9
U14,U29	14174	16	8
U15,U28	MM80C97N	16	8
U16,U32	MC14518BCP	16	8
U17,U47	MC14161BCP	16	8
U19	MC14175BCP	16	8
U22,U26,U40	MC14081BCP	16	8
U23,U34	MC14512BCP	16	8
U24	MC14071BCP	14	7
U25,U27,U48	MC14069BCP	14	7
U30	R-PACK 10K	—	14
U31	MC14532BCP	16	8
U39	4001	14	7
U41	74LS04	14	7
U42	4049	1	8
U43,U44,U46	HCPL-2731	8	5
U45	SN139	8	5
U49	MM74C221N	16	8
U53	R-PACK 10K	14	—
U54	HCPL-2601	8	5
U55	MC14070BCP	14	7

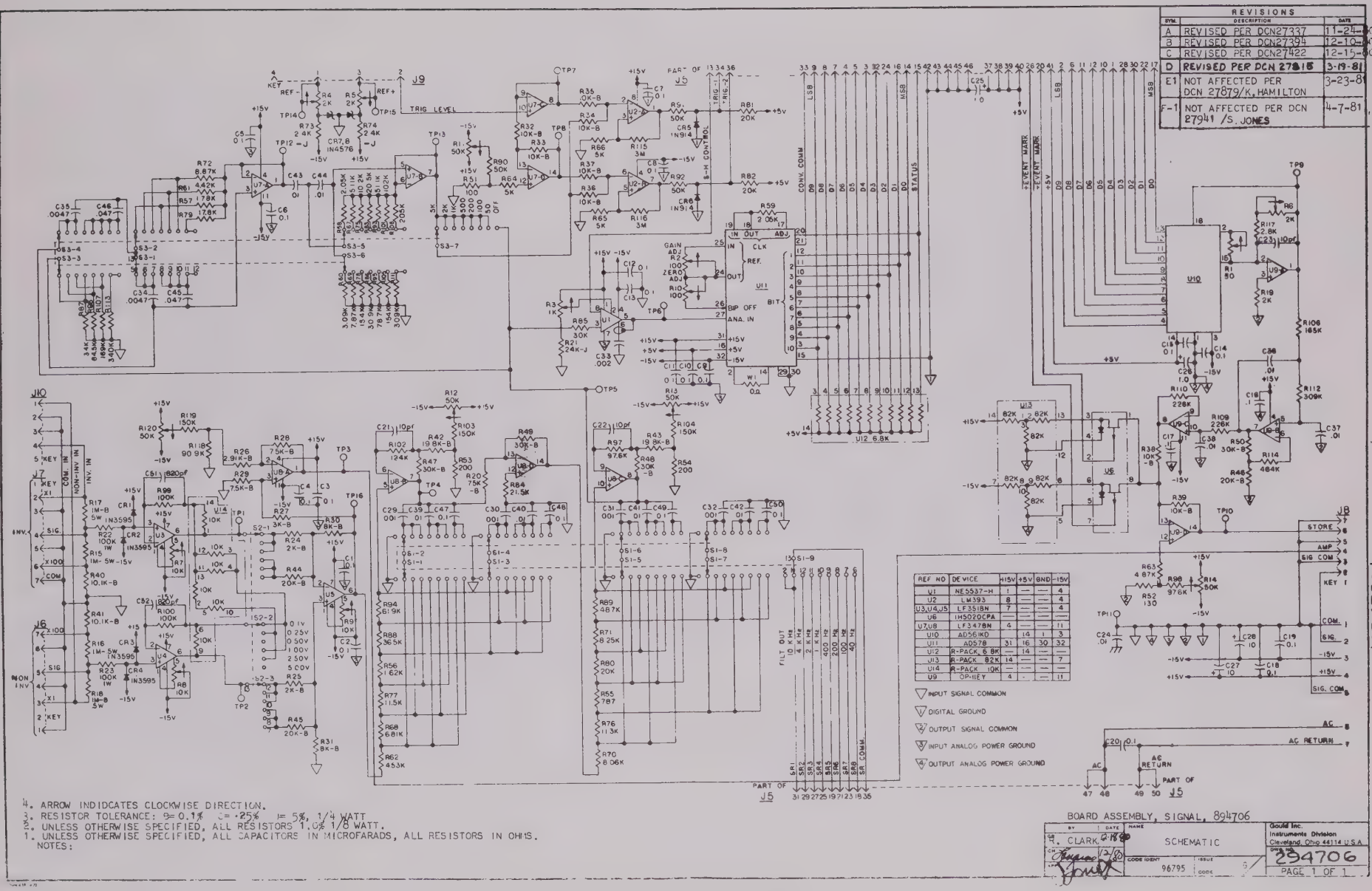
JUMPER CHART

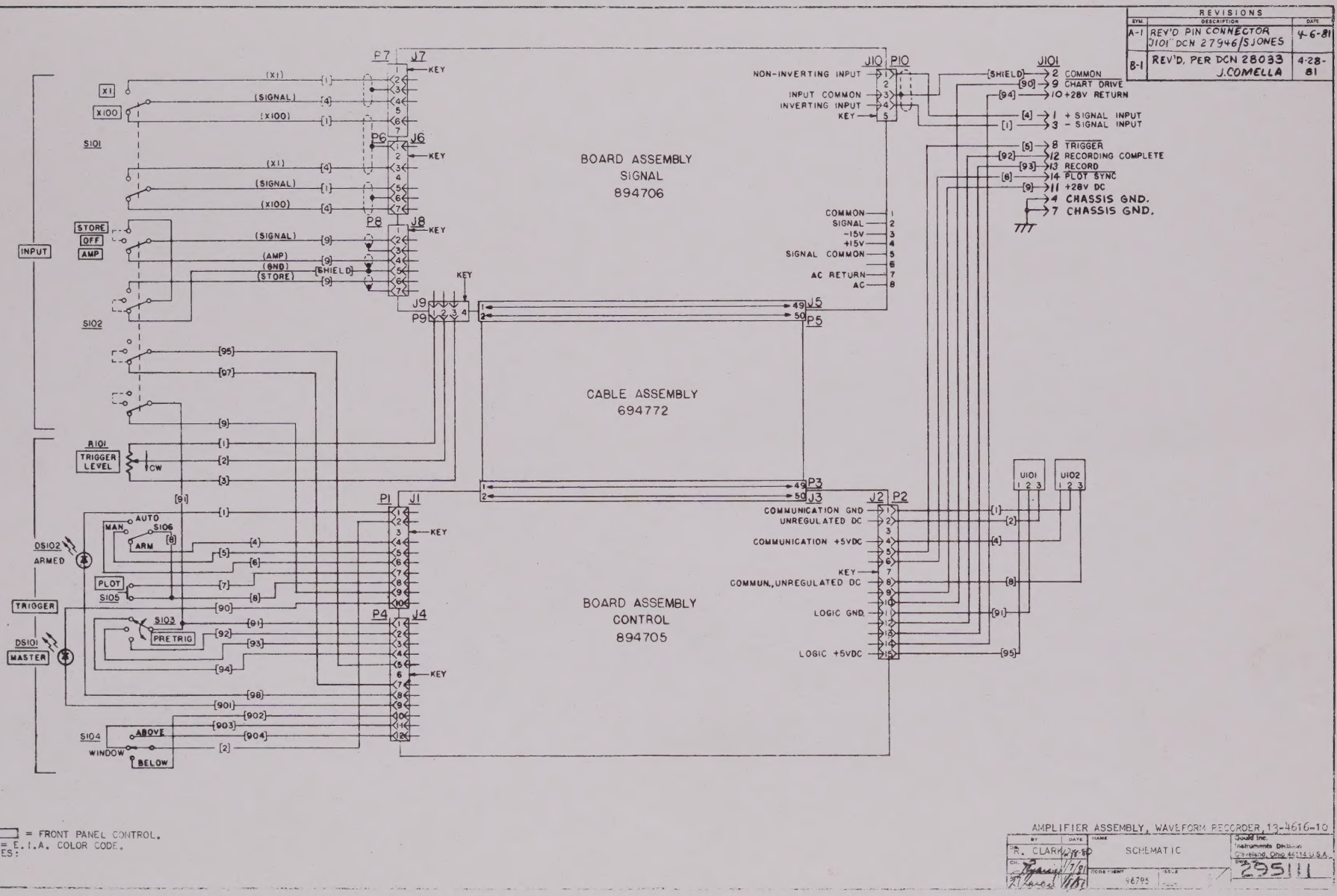
JUMPER	LOCATION	MEM WORDS
W1 W4 W6	C TO 2	2048
W1 W4 W6	C TO 1	1024

BOARD ASSEMBLY, CONTROL, 894705

BY	DATE	NAME	
DR.		P. CLARK	SCHEMATIC
CH.			
APP.			

CODE IDENT 96795 | ISSUE CODE G | Gould Inc Instruments Division Cleveland, Ohio 44114 U.S.A. | DWG. NO. 894705 | PAGE 2


REVISIONS
SYM | DESCRIPTION | DATE
A | REVISED PER DCN27337 | 11-24-80
B | REVISED PER DCN27394 | 12-10-80
C | REVISED PER DCN27422 | 12-15-80
D | REVISED PER DCN 27815 | 3-19-81
E1 | NOT AFFECTED PER DCN 27879/K, HAMILTON | 3-23-81
F-1 | NOT AFFECTED PER DCN 27941 /S. JONES | 4-7-81
REF | DEVICE | +15V | +5V | GND | -15V
U1 | NE5537-H | 1 | — | — | 4
U2 | LM393 | 8 | — | — | 4
U3,U4,U5 | LF351BN | 7 | — | — | 4
U6 | IH5020CPA | — | — | — | —
U7,U8 | LF347BN | 4 | — | — | 11
U10 | AD561KD | — | 14 | 1 | 3
U11 | AD578 | 31 | 16 | 30 | 32
U12 | R-PACK, 6.8K | — | 14 | — | —
U13 | R-PACK, 82K | 14 | — | — | 7
U14 | R-PACK, 10K | — | — | — | —
U9 | OP-11EY | 4 | - | — | 11
INPUT SIGNAL COMMON
DIGITAL GROUND
OUTPUT SIGNAL COMMON
INPUT ANALOG POWER GROUND
OUTPUT ANALOG POWER GROUND
4. ARROW INDIDCATES CLOCKWISE DIRECTION.
3. RESISTOR TOLERANCE: B= 0.1% C= ±25% J= 5%, 1/4 WATT
2. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS 1.0% 1/8 WATT.
1. UNLESS OTHERWISE SPECIFIED, ALL CAPACITORS IN MICROFARADS, ALL RESISTORS IN OHMS.
NOTES:
BOARD ASSEMBLY, SIGNAL, 894706
BY: R. CLARK DATE: 2-18-80 NAME
SCHEMATIC
CODE IDENT 96795
Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A.
DWG 894706
PAGE 1 OF 1
1294706C1


REVISIONS
SYM. DESCRIPTION DATE
A-1 REV'D PIN CONNECTOR J101" DCN 27946/SJONES 4-6-81
B-1 REV'D, PER DCN 28033 J.COMELLA 4-28-81
BOARD ASSEMBLY SIGNAL 894706
CABLE ASSEMBLY 694772
BOARD ASSEMBLY CONTROL 894705
INPUT
X1
X100
S101
STORE
OFF
AMP
S102
R101 TRIGGER LEVEL
CW
S106 AUTO MAN ARM
DS102 ARMED
PLOT
S105
TRIGGER
S103 PRE TRIG
DS101 MASTER
S104 ABOVE WINDOW BELOW
NON-INVERTING INPUT
INPUT COMMON
INVERTING INPUT
KEY
COMMON
SIGNAL
-15V
+15V
SIGNAL COMMON
AC RETURN
AC
COMMUNICATION GND
UNREGULATED DC
COMMUNICATION +5VDC
COMMUN., UNREGULATED DC
LOGIC GND.
LOGIC +5VDC
COMMON
CHART DRIVE
+28V RETURN
+ SIGNAL INPUT
- SIGNAL INPUT
TRIGGER
RECORDING COMPLETE
RECORD
PLOT SYNC
+28V DC
CHASSIS GND.
CHASSIS GND.
2. [ ] = FRONT PANEL CONTROL.
1. [ ] = E.I.A. COLOR CODE.
NOTES:
AMPLIFIER ASSEMBLY, WAVEFORM RECORDER 13-4616-10
SCHEMATIC
Gould Inc. Instruments Division Cleveland, Ohio 44113 U.S.A.
DWG. 295111
46795

www.manualsplus.com
1020400

Gould Inc., Instruments Division
3631 Perkins Avenue, Cleveland, Ohio 44114
Telephone (216) 361-3315

GOULD
Electronics & Electrical Products